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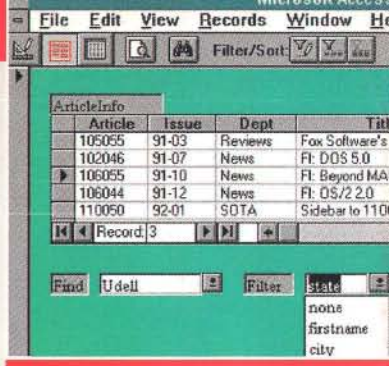

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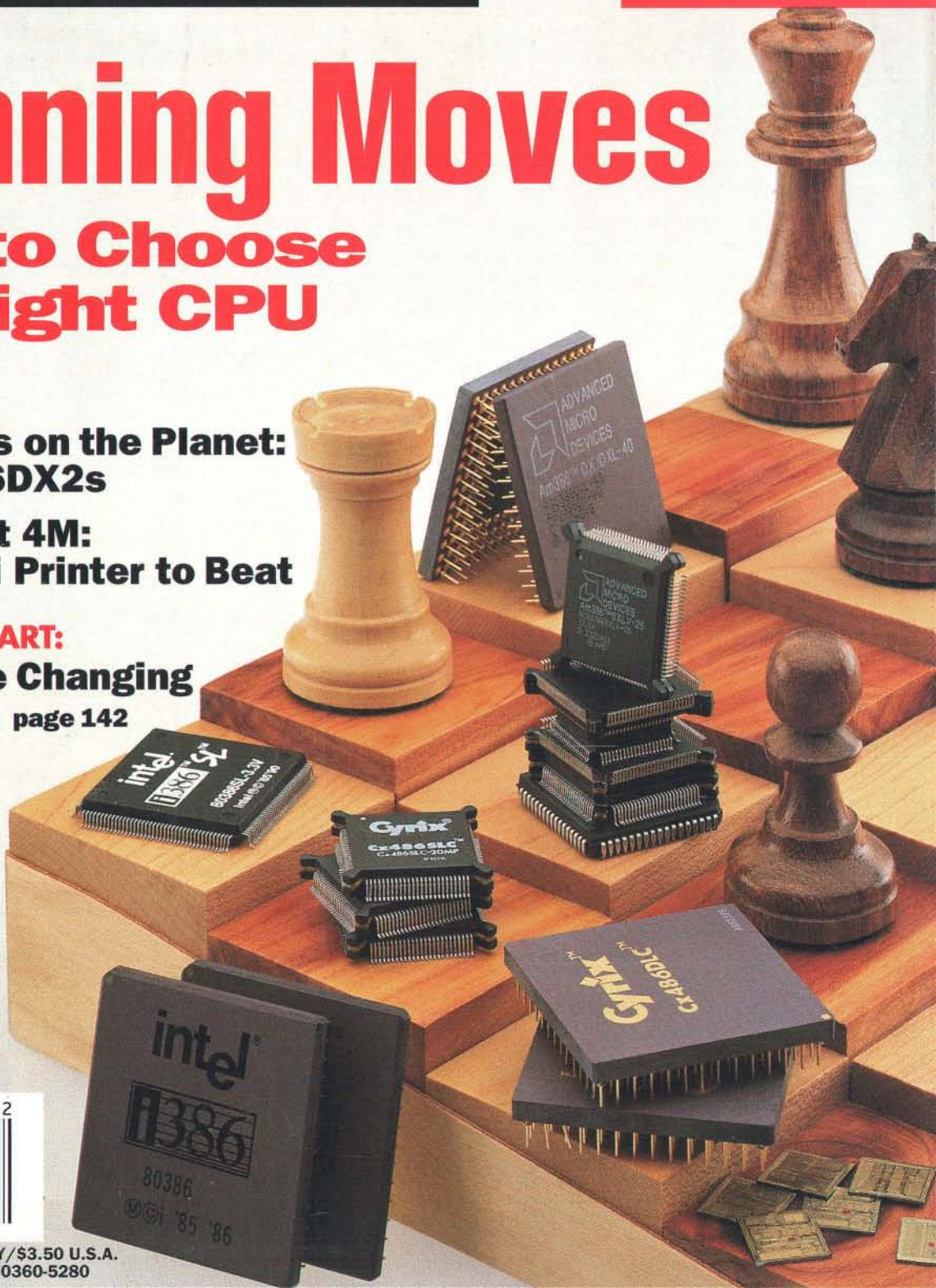

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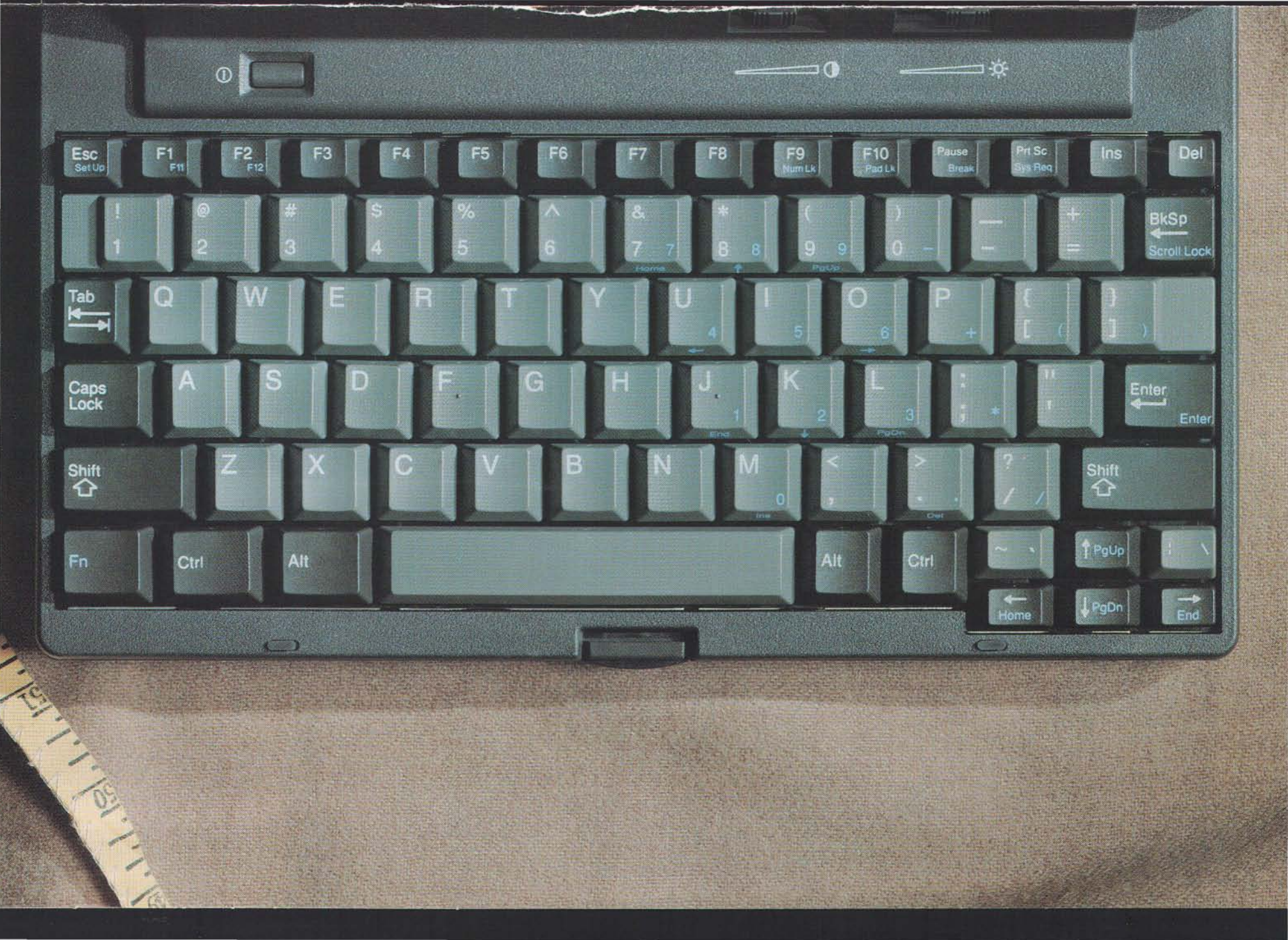
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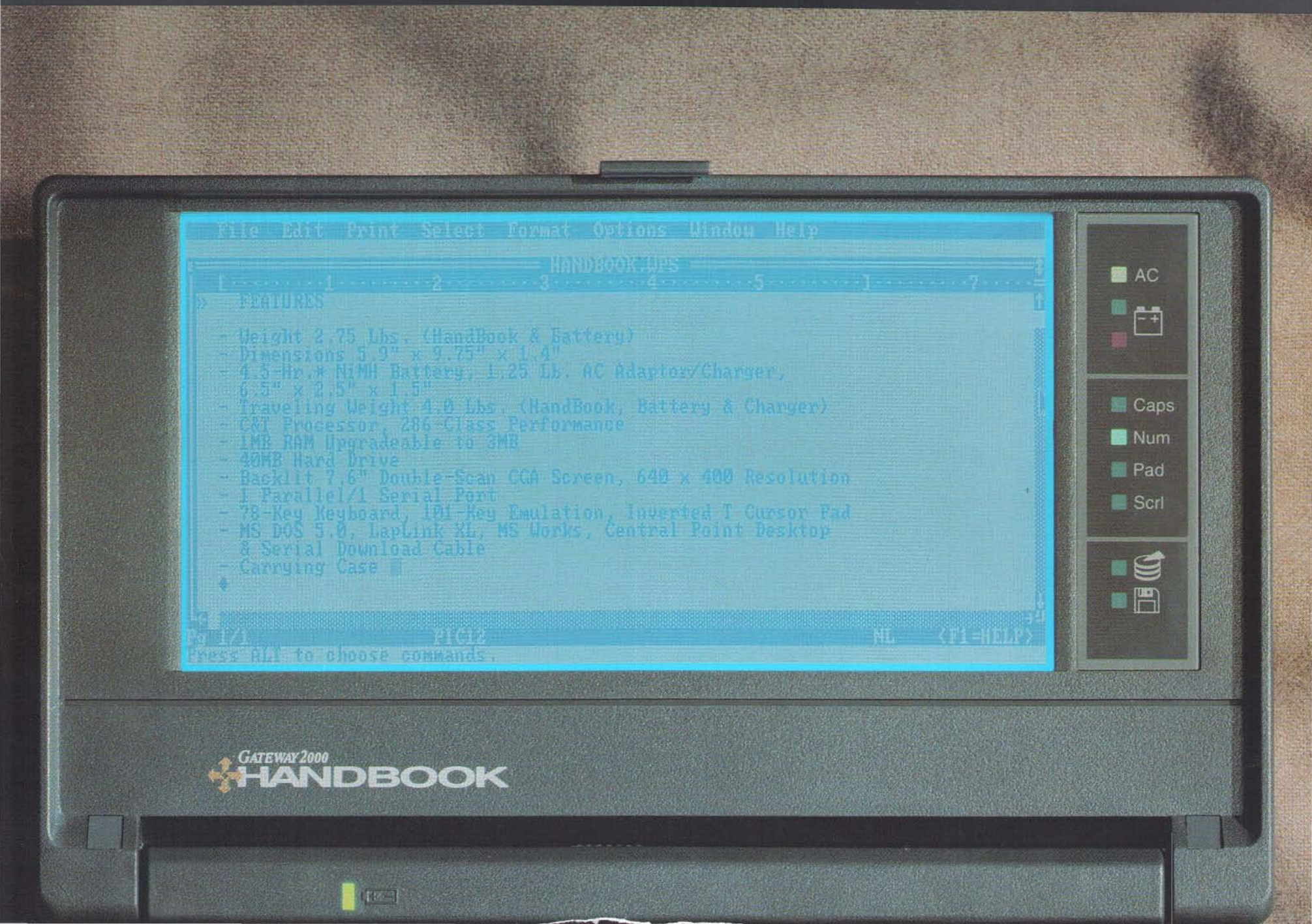
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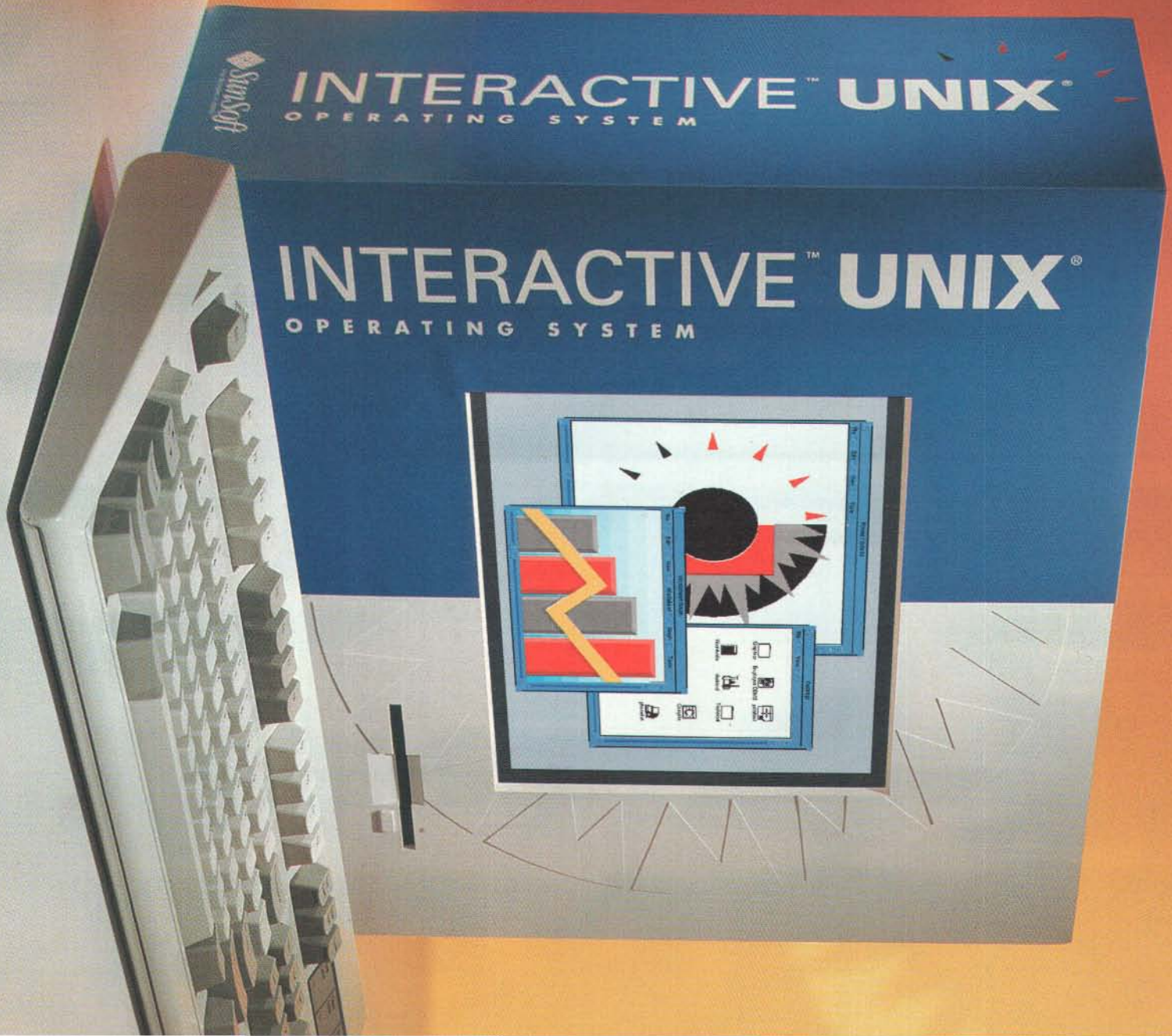
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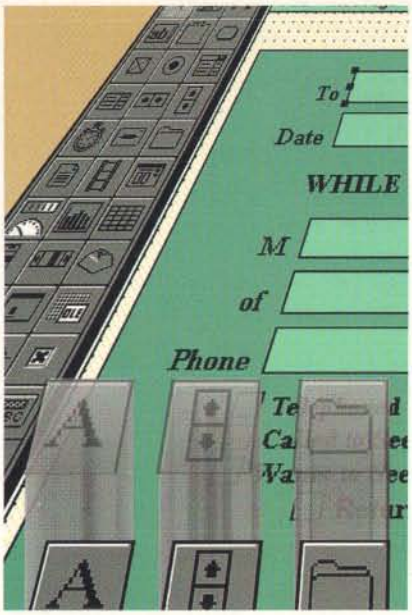

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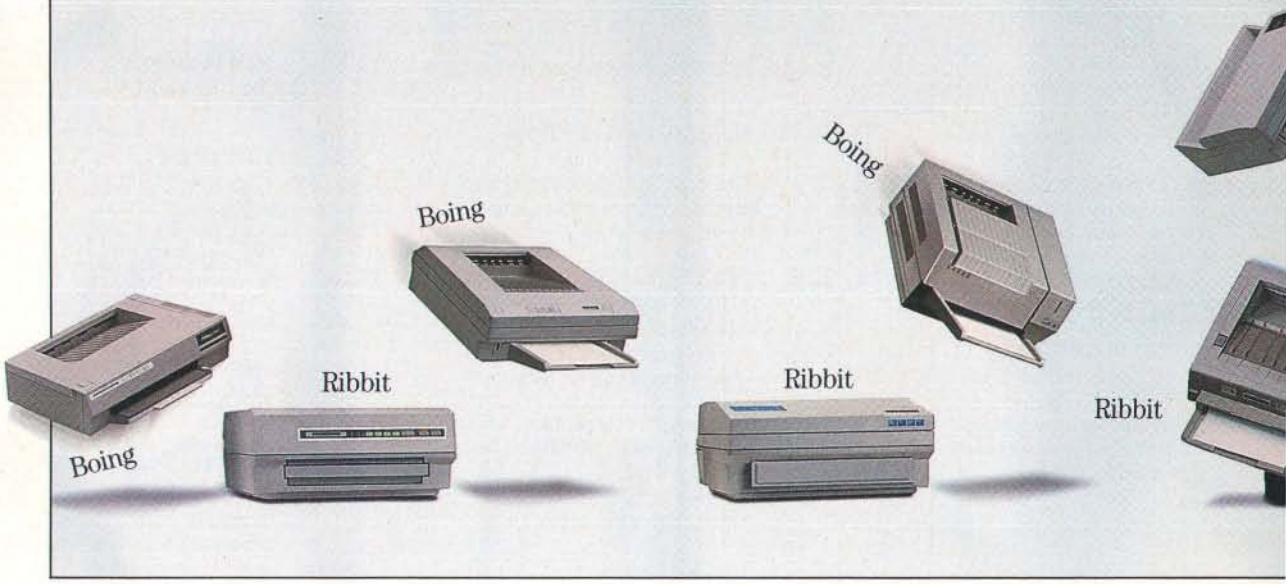
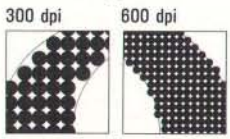
Other laser printers play leapfrog trying to catch up with the HP LaserJet.



The new HP LaserJet 4 printer isn't a hopped-up version of the past generation. Its new, advanced design sets much higher standards for print quality, speed, built-in features and value than ever before.

Higher resolution. More typefaces.

Unlike other 600 dpi laser printers, the HP LaserJet 4 was designed for 600 dpi printing from the ground up. As a result, it produces the best 600 x 600 dpi resolution ever for noticeably crisper, clearer text and graphics. At less than a 300 dpi price.



Four times the dots for better resolution.

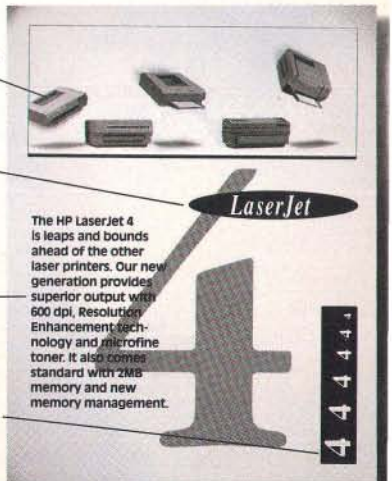
Microfine toner and HP's exclusive Resolution Enhancement technology give you razor-sharp edges and much smoother curves.

With 45 scalable typefaces built into the printer, users can produce a wide variety of documents. Without hassling with downloading or accessory cartridges. Or buying additional typefaces.

More speed, more trays, more flexibility.

Thanks to a new RISC processor, tuned vector graphics and faster I/Os, the HP LaserJet 4 also sets new standards for speed. It even prints many 600 dpi graphics at a true 8 pages per minute. It's faster on networks, too.

With 2 MB of memory built in and new internal memory compression algorithms, virtually all 300 dpi and many 600 dpi documents print from standard memory. Two standard paper trays, with a total capacity of 350 sheets, and an optional 500-sheet tray let users keep printing without constantly reloading different sizes and types of paper. And the optional 75-capacity power envelope feeder saves them from manual feeding. Or dealing with jams.



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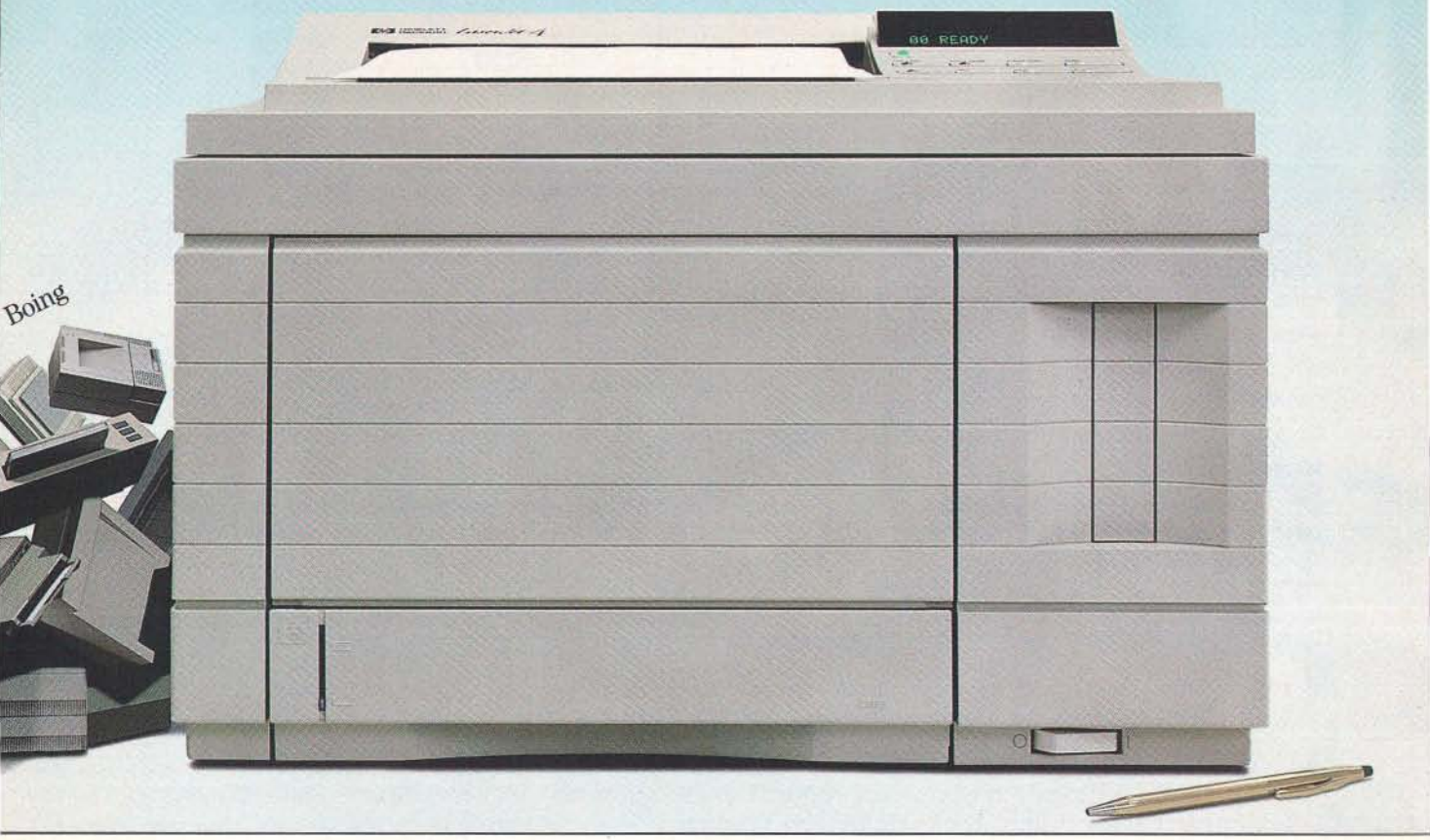
Introducing the new HP LaserJet 4 printer. So advanced, there's no catching it.



Mixed environment compatibility. Faster Windows.
The LaserJet 4 is very much at ease with most languages and personal computing platforms. Automatic switching lets it switch between HP's PCL 5 printer language and optional PostScript Level 2 software from Adobe. Hot I/Os allow different hosts to be connected simultaneously.

Optional JetDirect cards provide LAN connections to Ethernet, TokenRing, TCP/IP and LocalTalk/EtherTalk. This makes it easy to plug into just about any network, including PC and Mac LANs. And to get really fast network performance.

To optimize the LaserJet 4 for Windows printing, we codeveloped some breakthroughs with Microsoft.® Including Windows 3.1 TrueType fonts and rasterizer built in to make sure your users get fast, WYSIWYG printing. The fast Windows driver with HP-GL/2 vector graphics also enhances printing speed.

Several popular software drivers are included: Windows, WordPerfect and Lotus. As well as the new HP Explorer PC utility software, which provides a printing tutorial to guide your users through set-up and operation of the printer's new features.

All this makes the HP LaserJet 4 printer supremely simple to plug-and-play. As you'd expect, it also offers complete document and software compatibility with the HP LaserJet III printer.

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INSIDE BYTE

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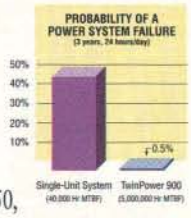

The TwinPower 900 comes in a monster case that holds two TC450 power supplies, the interface module, 6 fans, an 8-slot or 12-slot motherboard, and up to 13 drives. So, not only do you get the ultimate in power and reliability, you also get the ultimate in system expandability!

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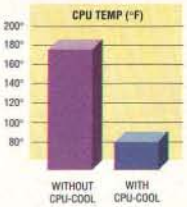
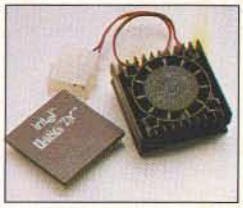
486 CPU COOLER





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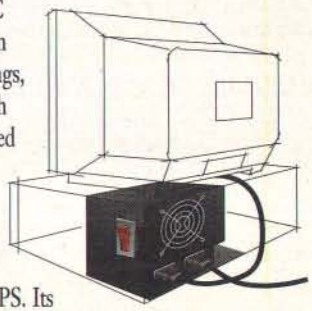

Protect your PC and its data from power surges, sags, and outages with our UL-approved InnerSource, a combined AT/Tower power supply and On-Line UPS. Its auto-recharge battery provides up to 15 minutes of backup power for both your PC and monitor. This reliable, integrated protection costs less than an equivalent 550VA external UPS, and it saves space too! A Novell interface is available.

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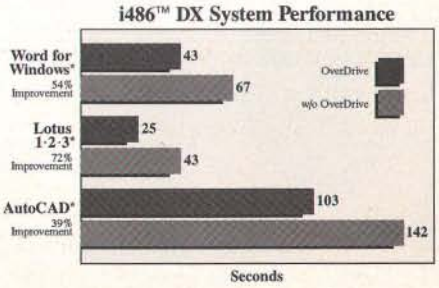
And that power will benefit every application you run on DOS, OS/2*, Windows*, or UNIX*—from AutoCAD* to WordPerfect* and



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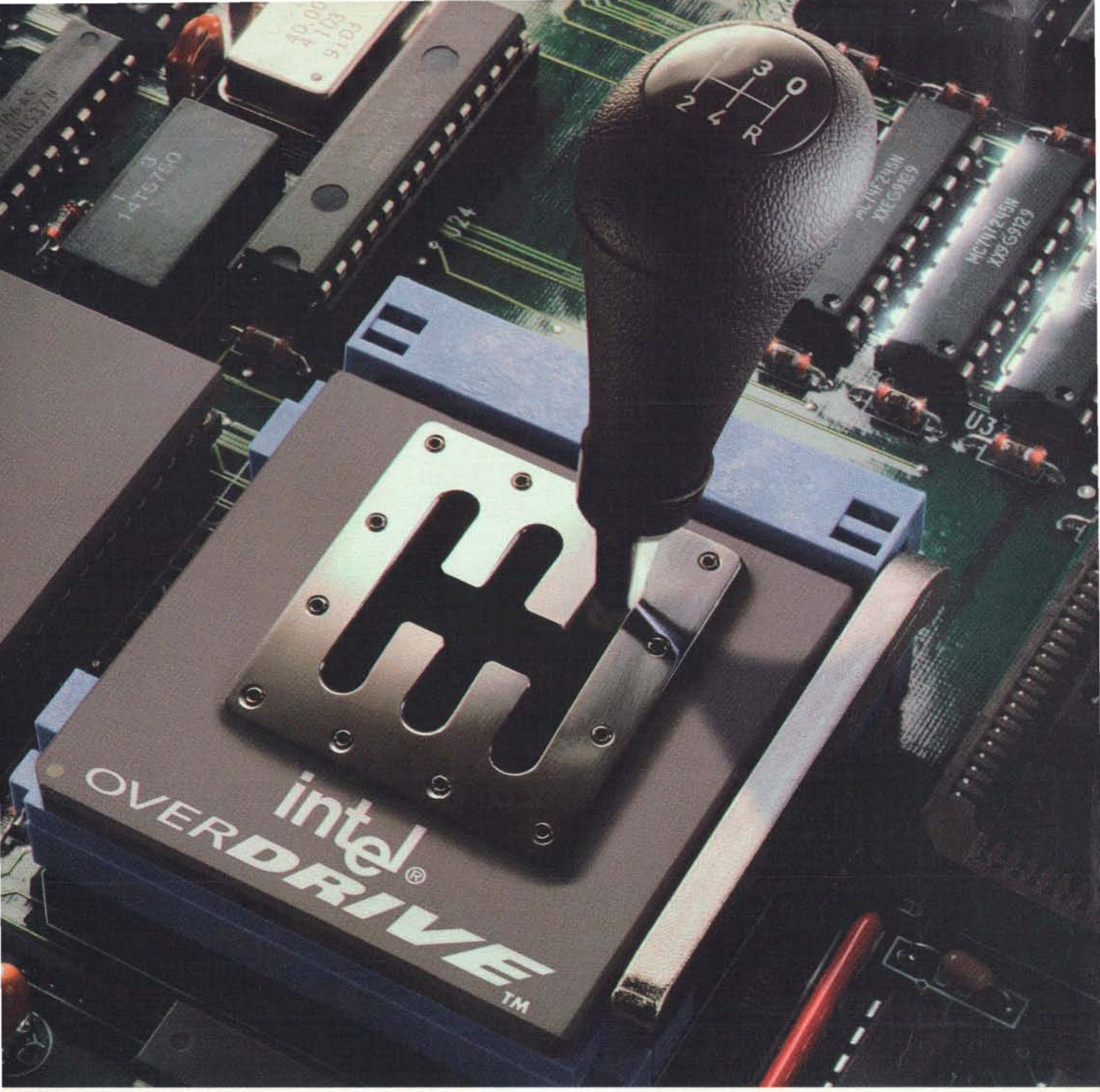

ware into high gear.

over 50,000 applications in between.

It's easy to install an OverDrive Processor. Just plug the single-chip upgrade into the vacant OverDrive socket* and you're ready to go. Faster.

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EDITORIAL

DENNIS ALLEN

TESTING AND CPUs

Does it *really* have to be Intel inside? Frankly, that's a good question, and it's a question that CPU makers Cyrix and AMD—who make Intel-compatible CPUs—would like you to ask. To make matters even worse, if you take the CPUs made by those companies and throw in a few from IBM, there are 14 varieties of Intel-compatible CPUs available, and the list is continually growing.

The premier computer testing lab becomes a member of the BYTE family

So the BYTE Lab took on the task of answering that question, and our testing editors began looking for the best way to evaluate the different processors. Performance benchmarks alone do not work—they're designed for testing complete systems. Moreover, system performance testing doesn't tell you much, if anything, about compatibility. And compatibility is the first concern buyers have in considering an Intel alternative. In the end, speed matters only if the CPU can run the software you want to use.

To address the compatibility issue, as well as to test the CPU speeds, we joined forces with the National Software Testing Laboratory, the leading testing company in the computer industry. NSTL was a pioneer in compatibility testing, and you may be familiar with the testing reports it publishes: *Software Digest*, *PC Digest*, and *LAN Reporter*.

NSTL has dozens of testing experts and occupies 20,000 square feet of a state-of-the-art test facility. The NSTL staff, much like the BYTE Lab staff, includes many of the most knowledgeable testing engineers and analysts in the world. By working with the talents of these people, we were able to answer some fundamental questions about CPUs. The whole story starts on page 114, and anyone who needs to know whether to buy an SX, SL, DX, or Intel-compatible CPU needs to read "Make the Right CPU Move."

This whole issue of testing is worth exploring. It seems like every computer magazine has some kind of lab, and readers must find it all a little confusing. Why, there are interoperability labs, LAN labs, Unix labs, multimedia labs, and so on and so forth. A photo of a competitor's lab even showed what looked like fiber-optic cable running around the room. On closer examination, however, that "fiber-optic cable" turned out to be a flashing disco light like the kind you can buy at Radio Shack.

The real worth of a testing lab is not measured by its name, its looks, or even its test equipment. It's the people who plan, develop, and conduct those tests and write the analysis that matter. The quality of the test data depends on the ability and the integrity of the technical people who operate a testing lab.

It's one thing to write an article for BYTE—that takes considerable talent and expertise. But to develop and conduct a test to meet BYTE's requirements is something that only a few people are qualified to do. Our standards are tough because that's what you demand, and I'm happy to say that NSTL meets those standards.

In fact, I'm particularly delighted to announce that NSTL and its staff are now part of the BYTE family. Wait, *delighted* is too mild a word—I'm really excited. This new alliance with NSTL will let BYTE bring you the absolute best information on products and technology.

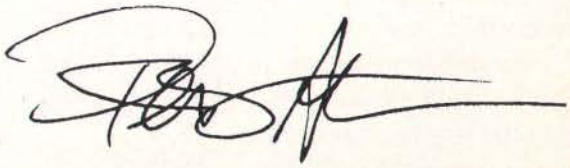
NSTL has a large suite of over 60 testing methodologies that range from performance to compatibility to usability. NSTL's commercial testing division has performed private tests for customers with familiar names like AMD, Borland, Cyrix, IBM, Intel, Lotus, Microsoft, and others.

NSTL has developed the most extensive private testing facility for computers in the world. And like BYTE, NSTL is a worldwide leader, with locations or affiliate operations in France, the U.K., Canada, and Singapore.

Highly skilled people, a worldwide operation, a large-scale testing facility, expertise in compatibility testing—it's easy to see that NSTL and BYTE are a good match. You can also bet your bottom dollar that in a few short months, our joined forces will bring something new to computer publishing.

No, we won't make BYTE one big product review. We'll continue to provide proportioned coverage of technology and products that helps you make strategic decisions. BYTE is committed to delivering the information you need—not a lot of fluff.

So what's really cooking at BYTE and NSTL?
WATCH THIS SPACE.

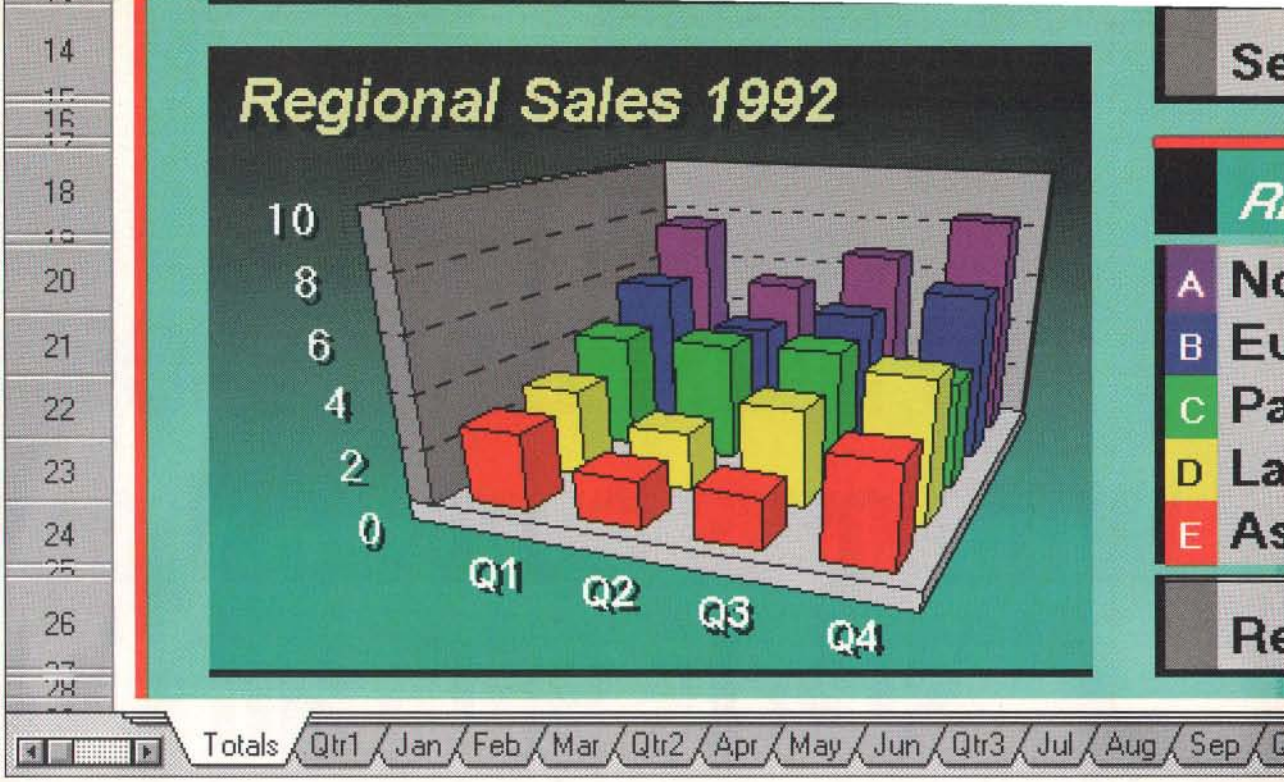


—Dennis Allen
Editor in Chief

The most advanced Windows spreadsheet starts with an elementary concept

Introducing Quattro® Pro for Windows.

BORLAND



...Spreadsheet

Quattro Pro for Windows *is the most usable spreadsheet ever made. Built with Borland's renowned object-oriented technology, Quattro Pro for Windows* is packed with hot new features you won't find in any other spreadsheet.*

NEW! Spreadsheet Notebooks* with customizable Tabs are nothing less than a revolution in spreadsheet ease of use. Now you can intuitively organize and manage your spreadsheet data.

NEW! Object Inspector™ menus end the hassle of searching through menus. They're simpler than 1-2-3. Just click the *right* mouse button anywhere on the screen to get a list of what you can change and change it right there.

NEW! Database Desktop is the easiest way to incorporate dBASE® and Paradox® data into your spreadsheet. Just what you'd expect from Borland, the leader in database technology.

NEW! SpeedFill™ and **SpeedFormat™** slash setup time by automatically filling in spreadsheet headings and formats.

NEW! SpeedBars™ are context-sensitive and customizable. SpeedBar icons give you pushbutton access to your most frequently used commands.

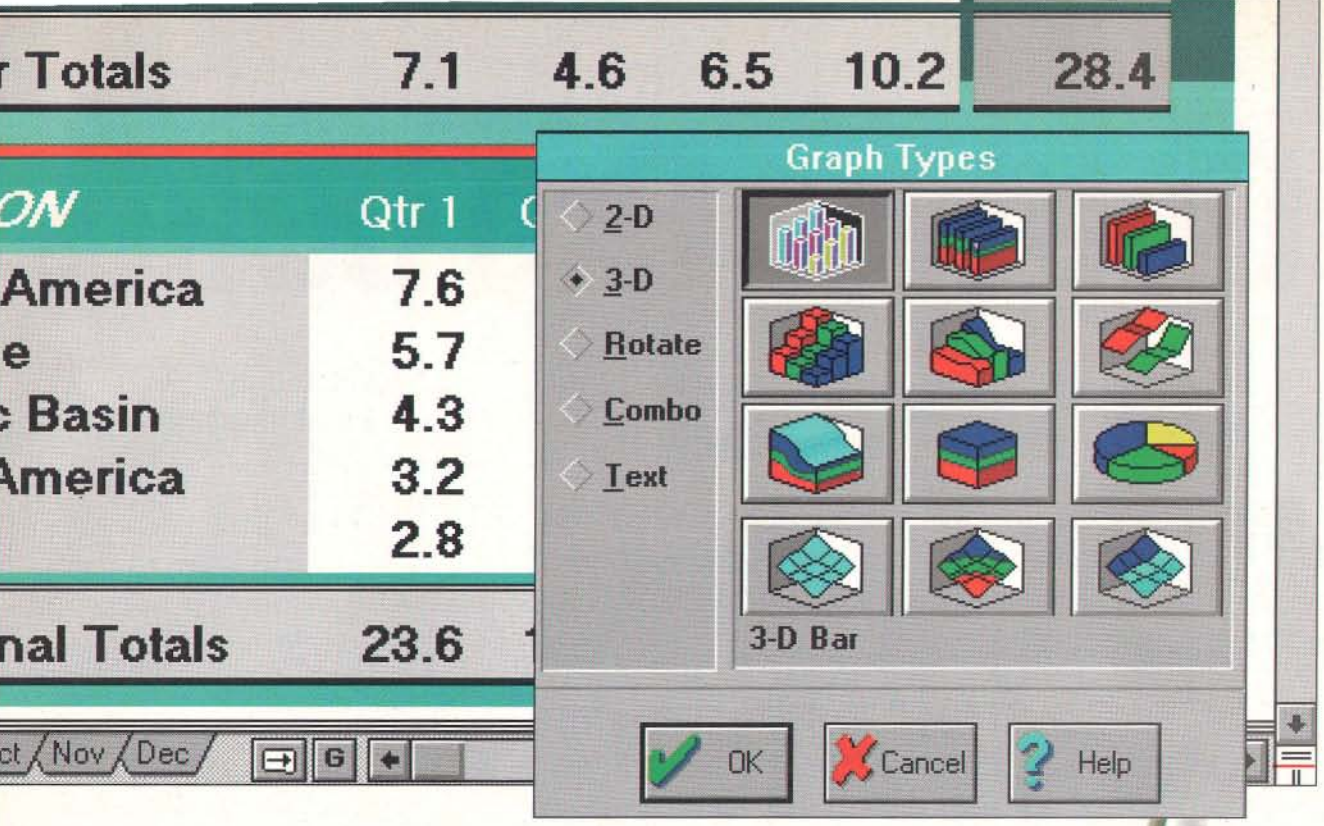
NEW! Presentation Graphics and drawing tools that rival those of Freelance and Harvard Graphics are built-in. You don't need to buy a separate graphics package.

YES! Compatible with Lotus 1-2-3 files, macros, and publishing styles and with Excel .XLS files.

Find your spreadsheet information in a flash!

From everyday tasks to complex projects, Spreadsheet Notebooks are the easiest way to work with your spreadsheets. By incorporating multiple spreadsheet pages in a single file (one notebook can handle up to 256 spreadsheet pages), you can break any complex spreadsheet into easy-to-manage pieces. Assign meaningful names to your notebook tabs and finding information is as easy as flipping through a notebook.

Notebooks are the smart way to do 3-D spreadsheets! You can present data in flip-chart style and format pages in a group, like chapters. Because you navigate easily, it's simple to build multi-page models.



Notebooks

You may never open the manual

Quattro Pro for Windows is the most usable spreadsheet ever. With Quattro Pro for Windows' object-oriented user interface, every action you take is easier and faster.

OBJECT INSPECTOR™ The Right Choice

Object Inspector menus let you make one-step changes to any object on your screen with just a click of the *right* mouse button—no more searching through layers of pull-down menus.

Context-sensitive, customizable **SpeedBars**™ give you pushbutton access to your frequently used commands. **Drag and Drop** lets you move or copy data instantly with the mouse.

Built-in graphics rival standalone packages

Quattro Pro for Windows gives you extraordinarily powerful graphics tools *built-in*. You'll never have to learn a separate graphics package.

Get 35 2-D and 3-D graph types—with thousands of variations. Then enhance your graphs by adding text, lines, arrows, and built-in clip art.

Use the **Slide Show** and **Light Table** to create incredible electronic presentations. Arrange and rearrange slide shows in seconds and customize them with dazzling transition effects.

You can create 35mm slides and overheads, too. No other spreadsheet gives you all this presentation power.

*Quattro Pro for Windows and Spreadsheet Notebooks have patents pending.

Circle 73 on Inquiry Card (RESELLERS: 74).

Notebooks | Object Inspector | Database Access | 1-2-3 Compatibility | WinDOS Offer

Quattro Pro beats

Other spreadsheets don't compare

FEATURE	QPW	EXCEL 4.0	1-2-3/W R1.1	1-2-3 R2.4	1-2-3 R3.1
ORGANIZATION					
Spreadsheet Notebooks	Y	N	N	N	N
Nameable Tabs	Y	N	N	N	N
Group Formatting on Selected Pages	Y	Y	N	N	N
True 3-D Consolidation	Y	N	Y	N	Y
EASE OF USE					
Right Mouse Button Formatting	Y	Y	N	N	N
Object Inspectors	Y	N	N	N	N
Context-sensitive SpeedBars	Y	Y	Y	N	N
SpeedFill and SpeedFormat	Y	Y	Y*	N	N
Drag and Drop	Y	Y	N	N	N
GRAPHICS AND PRESENTATIONS					
3-D Graphs	Y	Y	N	N	N
Slide Show with Light Table	Y	N	N	N	N
Live Linked Graph Types and Formatting in Slide Shows	Y	N	N	N	N
DATABASE ACCESS					
Live View of Networked Database Tables	Y	N	N	N	N
Database Desktop	Y	N	N	N	N
CUSTOMIZATION					
Macro Buttons on Spreadsheet	Y	Y	N	N	N
Visual User Interface Builder	Y	N	N	N	N
COMPATIBILITY					
Reads Quattro Pro, Excel, 1-2-3 Files and Styles (including Allways & Impress)	Y	N	N	N	N
Runs Your QPro & 1-2-3 Macros†	Y	N	N	N	N
ANALYSIS					
Optimizer	Y	Y	Y	N	Y

*Requires add-in.

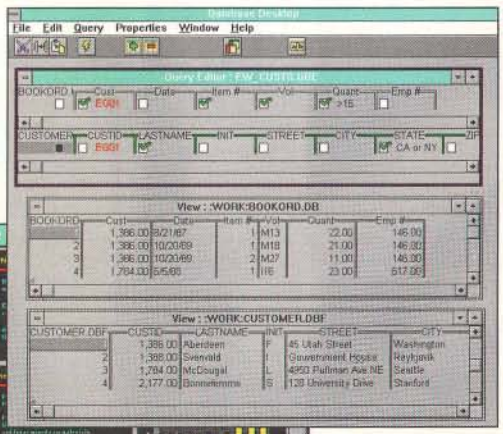
†Some 1-2-3 macros may require modification.

Outstanding 1-2-3 and Excel compatibility

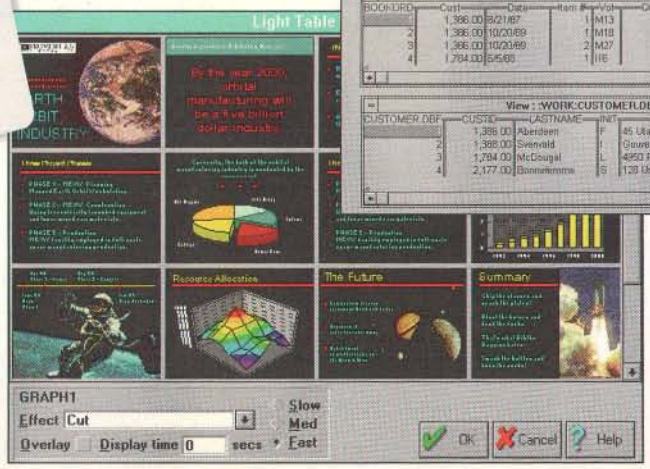
Quattro Pro for Windows is the next-generation Windows spreadsheet. It is the *only* spreadsheet that gives you both innovation *and* compatibility with Lotus 1-2-3, Excel, and Quattro Pro. Quattro Pro for Windows supports 1-2-3 files, macros, and publishing styles, including Allways, Impress, and WYSIWYG. It also supports Excel .XLS 3.0 and 4.0 files. What's more, Quattro Pro for Windows is much more compatible with 1-2-3 than Excel. For example, unlike Excel, Quattro Pro formulas, ranges, and command actions (like moving blocks) work as 1-2-3 users would expect.

Fast database access to dBASE and Paradox

Only Quattro Pro for Windows gives you easy access to database information. Borland's unique Database Desktop™ lets you view, edit, and copy dBASE and Paradox tables *directly* from within Quattro Pro. And *only* Quattro Pro for



▲ *The Database Desktop: Only Borland makes access to dBASE and Paradox data this easy with QBE.*



Only Quattro Pro for Windows gives you a Light Table to arrange your electronic slide shows in seconds. ▶

1-2-3 and Excel!

Windows has Query By Example, so you can ask questions about your data with point-and-click ease. Since it's from Borland, the database leader, you can count on it working right, even in network environments.

Create custom applications in minutes

Because of its object-oriented design, *only* Quattro Pro for Windows makes it easy to customize your spreadsheet. All the tools are there for you to create your own custom dialog boxes, powerful time-saving macros, and SpeedBars.

Don't settle for second best

Independent tests conducted by Usability Sciences Corporation find that two out of three Windows spreadsheet users tested preferred Quattro Pro for Windows. Don't settle for second best—get Borland's Quattro Pro for Windows today!

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"Quattro Pro for Windows is [what] Lotus should have released, but didn't."
InfoWorld

"Quattro Pro 4.0 [is] the ultimate DOS spreadsheet."
PC Magazine

90-DAY GUARANTEE MONEY-BACK

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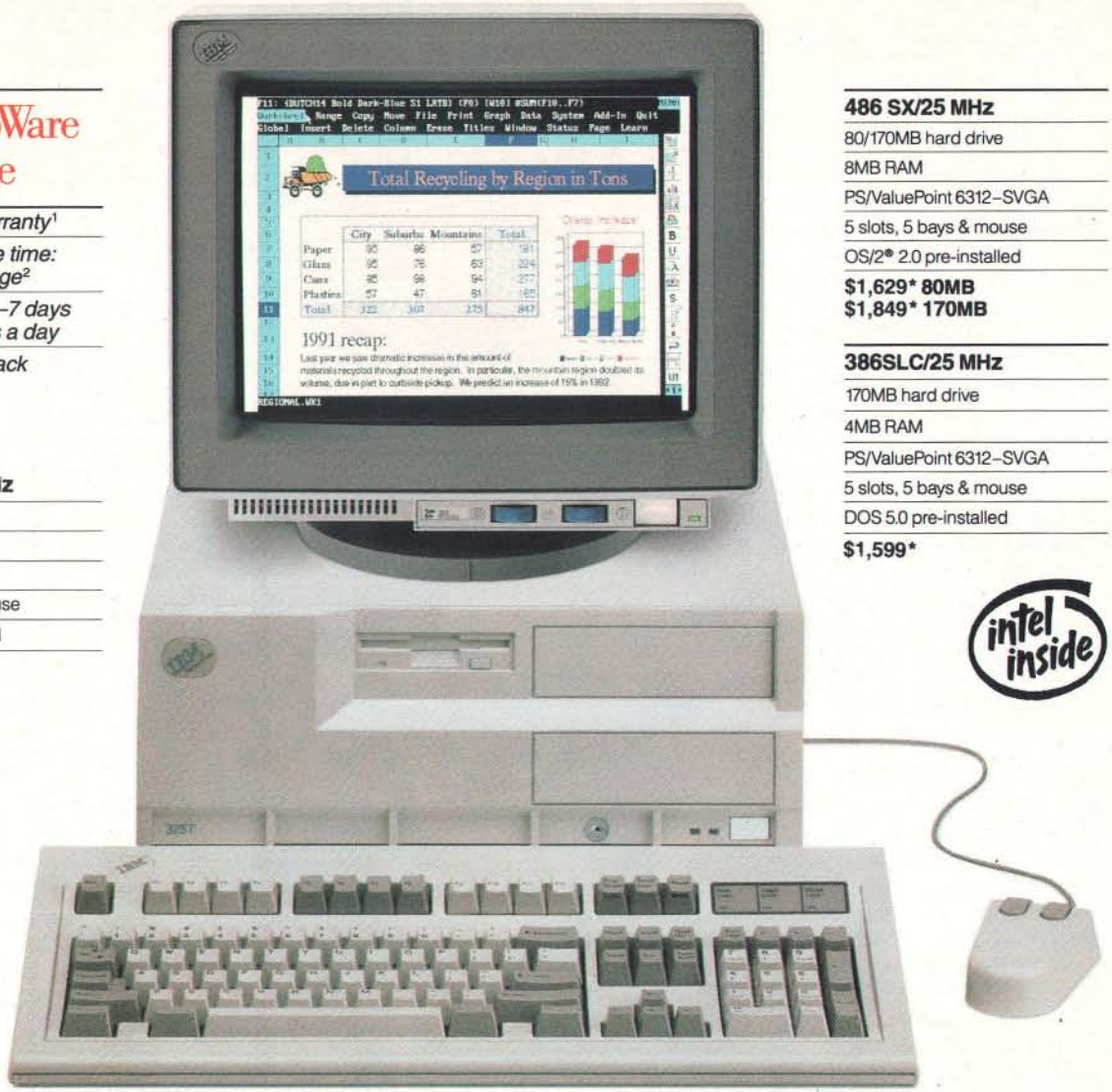

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LETTERS

Is Unix Dead?

In "Is Unix Dead?" (September), Tom Yager and Ben Smith delivered a cogent discussion of the current state of Unix. The U.S. Department of Commerce's Thomas Giammo notwithstanding, the article did not, as its title suggested, buy into the Windows NT scam. Giammo's assertion that Windows NT will wipe out Unix by the mid-1990s reflects the marketing hysteria perpetrated on corporate America by Microsoft.

To suggest that Windows NT is going to blow Unix off the desktop and into programming oblivion is to forget a simple truth: Unix is simply one of many capable players in the field. And it has just started to move to the desktop in the last five years. Business is making a heavy investment in Unix worldwide for a very good reason. Unix is not simply another operating system. It is the lingua franca of operating systems.

Mike McKinlay
Dubuque, IA

Your September cover story, wherein you suggest that Windows NT would provide the "most powerful adversary [to Unix] to date," was published at the wrong time. April 1 would have been more apropos.

On the other hand, I might be wrong. As soon as Windows NT is available in Cray XMP or Convex C-220 versions, I'll be happy to consider turning these machines into single-user systems for the sake of a "well-integrated scalable font subsystem."

My research group and I would like to thank you for a good belly laugh.

Daniel P. Dolata
Tucson, AZ

I was befuddled by your September cover story, which states that "soon, Unix will face its most powerful adversary to date: Microsoft Windows NT. Will Unix survive?" How can BYTE make a comparison between a venerable, proven operating system like Unix and a big question-mark vaporware operating system like Windows NT? Unix, like DOS, is here to stay. But Windows NT? Couldn't you have compared Unix with an operating system (e.g., OS/2) that is on the market today and has known features and capabilities? I was amazed that the authors mentioned OS/2 only three times, as little more than a footnote to the imagined "big battle" between Unix and Windows NT.

Dan Butterfield
Keller, TX

I would like to respond to "Is Unix Dead?" and Dennis Allen's editorial comments regarding Unix-specific magazines. While Unix has a tradition of technical innovation, that is not the reason for its past growth and continuing global success. What your story fails to mention is the desire, on the part of the world's major computer customers, not to be tied to a single vendor for any computing solution. Using open systems such as Unix, these companies have been freed from the bonds of proprietary mainframe and minicomputer vendors. So why would they want to return to a single vendor for their desktop solution? The answer is that growing numbers don't and won't.

At *UnixWorld*, we regularly address the shortcomings of Unix and the potential of its challengers. Although we respect the marketing clout of Microsoft, we won't fall for its hype about Windows NT so hard that we write a premature obituary for Unix.

Dave Flack
Editor in Chief
UnixWorld

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BYTE International

Thank you for the editorial announcing BYTE's new international focus and the elimination of the separate International and U.K. pages. I had been planning to write to say that I would prefer to receive a U.S. version of BYTE, since I already read about U.K. developments in the U.K. magazines. I am pleased, therefore, to see the removal of the U.K. section in BYTE.

John Bamfield
Croydon, U.K.

The Artichoke Theory

Nolan Bushnell is right on target with his artichoke theory about the need to make user interfaces simpler and easier to learn (see "The Artichoke Theory," September). However, simplicity on a program-by-program basis is not enough. We need a way of working the low-level functions of every program into identical keyboard commands so that new users won't have to learn so many commands.

Why not design a new expanded keyboard with two or three rows of named universal function keys on the left as well as the usual function keys across the top and to the right? A few suggestions for new keys include Help, Print, Copy, Save, Macro, Find, and Exit. Programs would then be modified to support these function keys. Once a program was learned, the user could learn any other program without learning a new set of keystrokes.

Susan A. Henderson
Chicago, IL

I read "The Artichoke Theory" (September) and "The Productivity MacGuffin" (August) with interest. I think that the following factors are crucial to the lack of productivity: (1) People don't realize the value of system administration expertise, and (2) people don't use Unix.

Marty Leisner
Rochester, NY

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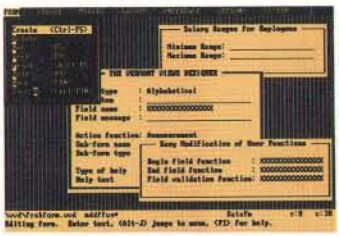

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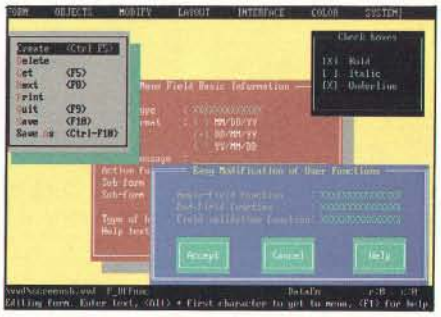

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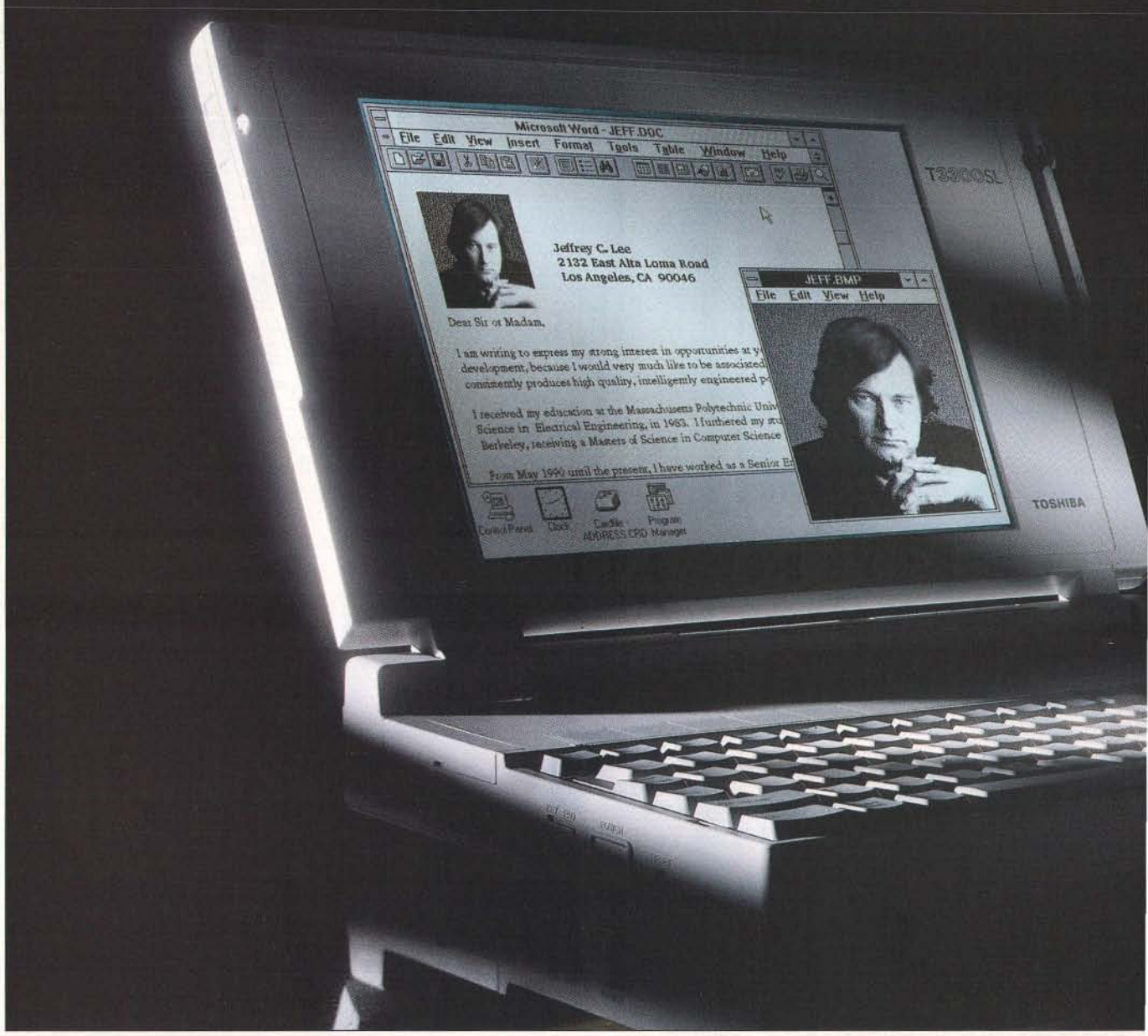

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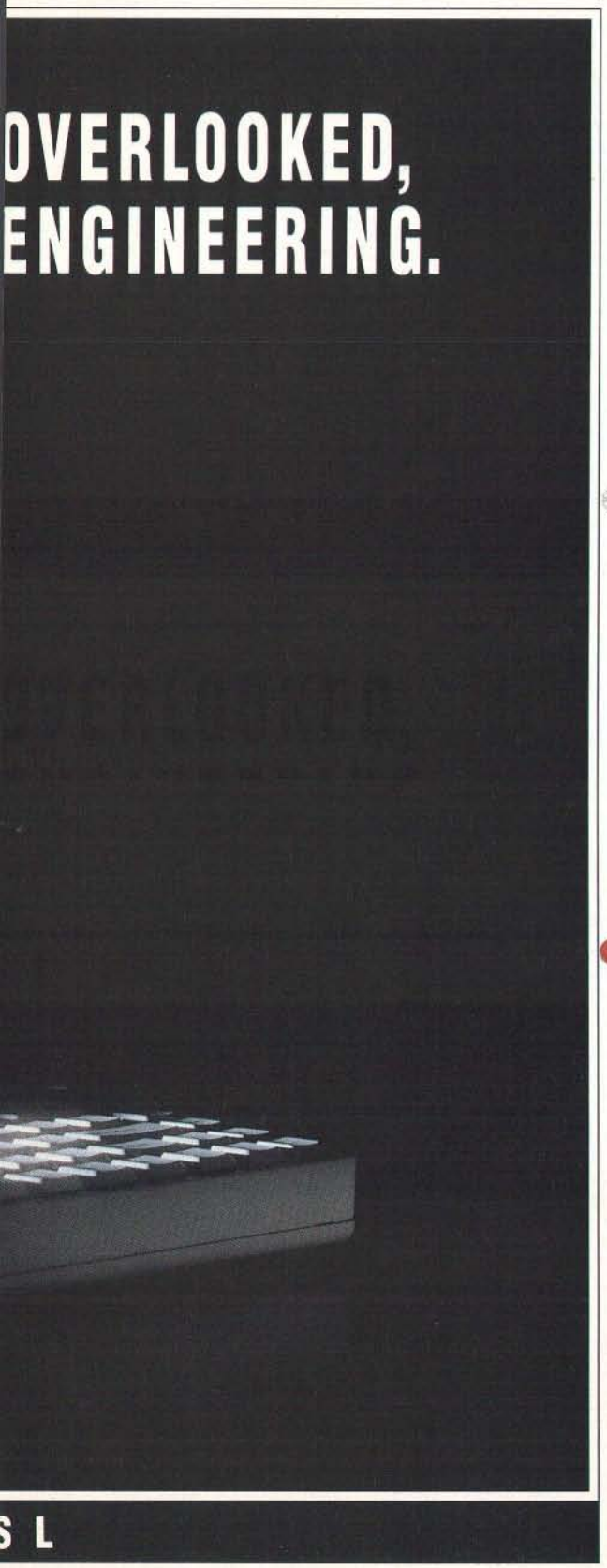

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Circle 162 on Inquiry Card.

PC Environmentalism

I'm grateful for the much-needed discussion you provided of the environmental costs associated with personal computing ("The Greening of Computers," September), but I must take issue with the authors' estimate of PC power consumption. The figure of 150 watts is hopelessly low. Perhaps they were confusing output supplied with input required. Even the original IBM PC, rated at a meager 63.5-W DC output, consumed 300 W, according to the technical reference manual.

My current 386/25 clone has a 200-W power supply, so it can support three times as much drain on its I/O bus as the original IBM PC, but its power consumption is listed as "90-130 VAC 6 AMP"—in other words, 110 volts × 6 amperes, or 660 W. Leaving my PC on all the time, even with the peripherals turned off, would consume 5780 kilowatt-hours—four times more than the figures given in the article.

Norm Gabowitz
Halifax, Nova Scotia

I am skeptical about the "greening of computers." I am not opposed to the idea insofar as it flows naturally from basic improvements to hardware and software. (The current 0.5-micron semiconductor technology is a good example.) But given the marginal quality of most hardware and software, I tremble at the consequences of making greening a major priority. When you make the machine ecologically pure, it is likely to be at the expense of functionality and reliability.

Turning a high-voltage device such as a monitor on and off more frequently is likely to accelerate the inevitable date when it blows out. The suggestion that it is ecologically desirable to put documentation on-line instead of printing it is nonsense, since computer manuals, unlike newspapers, are not normally discarded. It may be good to have on-line manuals for context-sensitive help, but much on-line documentation is not very context-sensitive. In the end, one is likely to print the documentation out, using far more paper and ink than would a printing press.

Let computers prove themselves as computers before vendors start asking for special favors because their computers are "green."

Andrew D. Todd
Philadelphia, PA

I'm encouraged by the efforts made by some in the computer industry to be part of the environmental solution. When is BYTE going to take up the cause and list the various environmental attributes of tested equipment in its BYTE Lab reports? Publishing power consumption, average material waste in production, and the like would be a powerful tool to encourage computer equipment vendors to consider more seriously the economic costs of ignoring their environmental record.

Rob Taylor
Vancouver, British Columbia

Object-Oriented Objections

I read "In Search of an Object-Oriented File System" (September) with some irritation. While Jon Udell is correct about the division of data and executable files in Windows and the need to use file extensions to specify who created what file, he's mostly wrong about OS/2.

My understanding of OS/2's extended file attributes and the Mac resource fork suggests that the two systems work rather similarly. If you use the HPFS (High Performance File System), you can name a file anything you damn well please, as long as it's less than 256 characters long. One of my Excel spreadsheets is named "Biosym.Costs.92-94." If you inspected the properties of this file, you'd find that the extended attributes include both the fact that it's an Excel spreadsheet and the appropriate icon. What's the difference between this and the Mac resource fork? While it is true that the number of properly HPFS-aware applications is small, they do exist and do work.

Finally, Udell's object-oriented file system allows him to search by file category. He can already do that through the HPFS and search by file type. This puts up a scroll list of all the registered file types (ASCII, OS/2 command file, and so on); he can pick one and search for it. A lot of what he describes works now in OS/2 and has since version 1.2. Udell ought to publish a clarification.

Adrian Goldman
Piscataway, NJ

Jon Udell may have erred in his discussion of the Workplace Shell. Native WPS applications should include document templates that contain associations, thus linking all documents to applications that can act on them. A true WPS application need not, and should not, have either print or file open options.

DOS applications are linked to their creators by file extensions. Linking each data file manually would be tedious, and because of the way that DOS applications save files, using extended attribute-based linkage is risky. File-extension linkage is very simple. Within a program reference object, the Association Settings option lets you add "names." The file extension is added in the form of *.txt, *.wk1, and so on. It is simple and effective. DOS applications also naturally support drag-and-drop launching.

John Faughnan, M.D.
Escanaba, MI

Dr. Faughnan points out that you can associate FAT (file allocation table) files with program reference objects by way of filename extensions. That's true. Mr. Goldman adds that HPFS files created by HPFS-aware OS/2 programs can also supply a type attribute (e.g., Excel spreadsheet) that you can use as a search key. That's also true.

My point, however, was that OS/2 2.0's WPS object system inhabits one hierarchical name space, and its file system inhabits another. You can build mappings between the two by creating WPS objects that refer to files. But when you search for something, where do you look: in the object system or the file system? Until the object system can seamlessly acquire the contents of existing file systems and capture all new work, you'll always be living in two parallel universes. This is emphatically not just an OS/2 WPS issue. Windows, NewWave, and the various Windows shell alternatives have the same problem (although NewWave, in particular, is more aggressive than OS/2 about acquiring existing files into the object system). I stand by what I said. We need real unification of objects and files, and finding an evolutionary solution is going to be tricky.—Jon Udell ■

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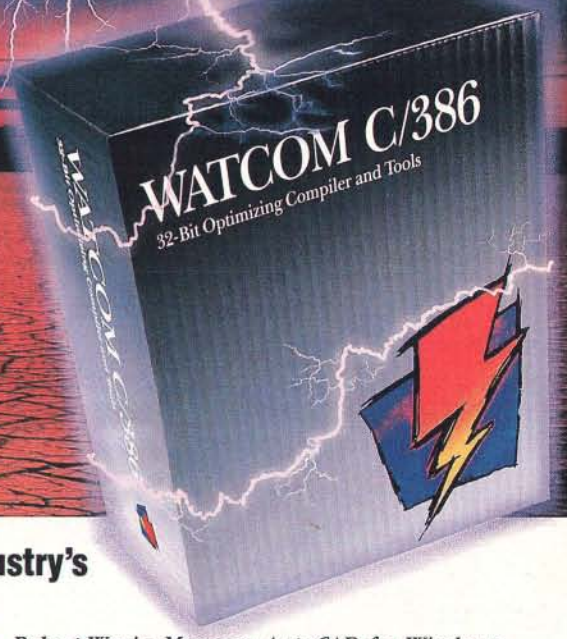

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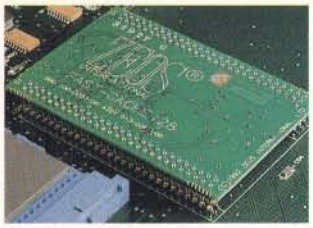

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NEWS

MICROBYTES

Coming Soon: Sparc Workstations at PC Prices

SPARC-compatible workstations priced similarly to high-end PCs are expected on the market by early 1993, thanks to a new low-cost microprocessor announced in October by Texas Instruments (Houston, TX). The new RISC-based microSparc (code-named Tsunami) delivers about 40 MIPS and costs only $179 in production quantities. Other comparable SPARC chips cost more than $500, and Intel's 486DX/50, a CISC microprocessor also rated at about 40 MIPS, costs $502.

TI developed the microSparc (see the photo) with Sun Microsystems (Mountain View, CA) and Mentor Graphics (Wilsonville, OR). The 50-MHz chip is compatible with SPARC International's Version 8 architecture and SPARC software.

Packing 800,000 transistors in a 0.8-micron CMOS, the microSparc includes a 32-bit integer unit, an FPU, an MMU (memory management unit), a data aligner/parity checker, a DRAM controller that you can configure, an I/O bus controller supporting five SBus slots, a 4-KB instruction cache, and a 2-KB data cache. Power consumption is less than 4 W. By comparison, a Sun Sparcstation IPX workstation requires 29 chips for the same functions and consumes more than 20 W.

Memory is addressed on a glueless 64-bit bus, allowing up to 128 MB of RAM. By mating the new microSparc chip with a pair of highly integrated I/O chips from NCR, systems designers need to add little more than memory and a clock crystal to build a workstation that includes a parallel port, serial ports, a SCSI connection, an Ethernet connector, and peripheral controllers.

In addition to breaking price barriers, the highly integrated microSparc chip consumes much less power than comparable SPARC processors, making it ideal for portable computers.

Several companies are working on microSparc-based systems for delivery early next year. Hyundai Electronics America (San Jose, CA) says it will have a workstation priced at under $5000 that will offer better performance than a high-end PC. Faye Briggs, Hyundai's senior director of engineering, said, "It [the microSparc] allows SPARC to come into a price range and achieve performance that no other chip can match today. IBM is trying to do the same thing with the PowerPC, but this chip is here today." A British laptop maker, Cambridge-based Tadpole, is said to be developing a microSparc portable, but company officials had no comment.

—Tom R. Halfhill

Windows Encroaches on Mac Color Publishing

SAN FRANCISCO—Microsoft Windows is rapidly invading Apple's turf of color desktop publishing, judging from new hardware and software shown at the Seybold Desktop Publishing Conference in September. Several companies are porting major Mac products to Windows 3.1.

For example, Quark (Denver, CO) announced that it had begun shipping to distributors its long-awaited Windows version of QuarkXPress, a desktop publishing program now popular on the Mac. Although users have access to rival applications (e.g., Frame Technology's FrameMaker for Windows), QuarkXPress has been an established tool among Mac users, especially professional desktop publishing bureaus, since version 3.0 was introduced in 1990.

SuperMac Technology (Sunnyvale,

NANOBYTES

Representatives for Microsoft (Redmond, WA) have confirmed that **Windows NT** won't ship in 1992 and may not ship before June 1993. Linda O'Neill, a spokesperson for Microsoft, said the company plans to follow this fall's beta release of Windows NT with another beta drop in January. She said that Microsoft will not release the operating system until the first or second quarter of 1993. Although many developers were expecting Microsoft to release the operating system by the end of the year, O'Neil said, "All along, the goal was to ship the product when done. It's not like we have to ship by December 31." □

John Warnock, CEO of Adobe Systems (Mountain View, CA), says his company is porting Photoshop to Silicon Graphics, Inc., RISC-based machines. During a demonstration of Photoshop on one of SGI's machines, he said that although the port "is in the early stages, the windowing speed and tiling of images is very encouraging. The ability to pan across images is impressive, and we haven't even done any optimization."

Warnock said the company is talking to third-party vendors to get their filters ported to SGI machines. Asked what would be the speed difference between the SGI version and Photoshop running on the fastest Mac, Warnock said, "A lot." Adobe's Premiere program for assembling and editing digital video movies is also being ported to SGI machines. Don't forget: Apple's QuickTime is also being ported to the SGI platform. □

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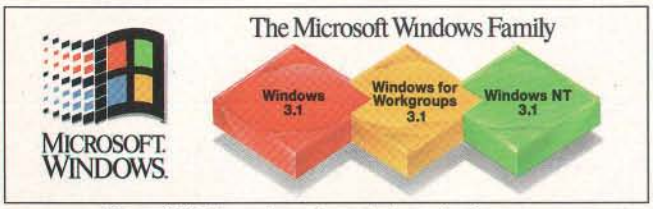

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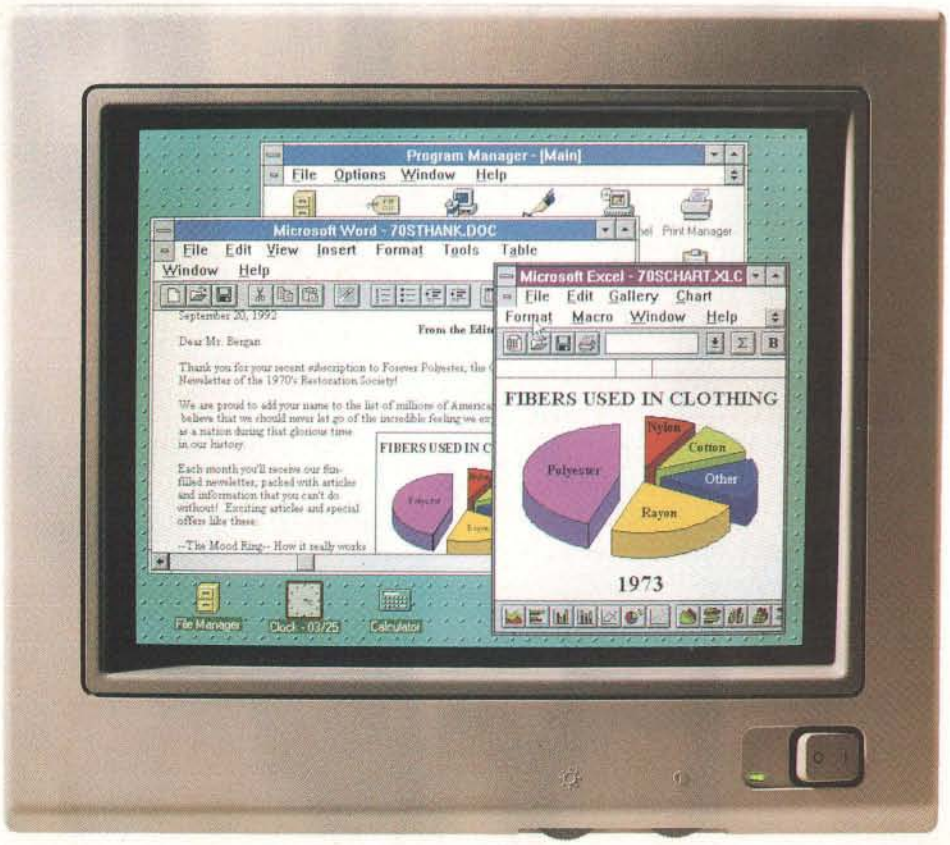

If you're a developer, you can get a copy of the Win32 Preliminary SDK for Windows NT by calling Microsoft Developer Services at (800) 227-4679. *© 1992 Microsoft Corporation. All rights reserved. Printed in the USA. Inside the 50 United Sta*

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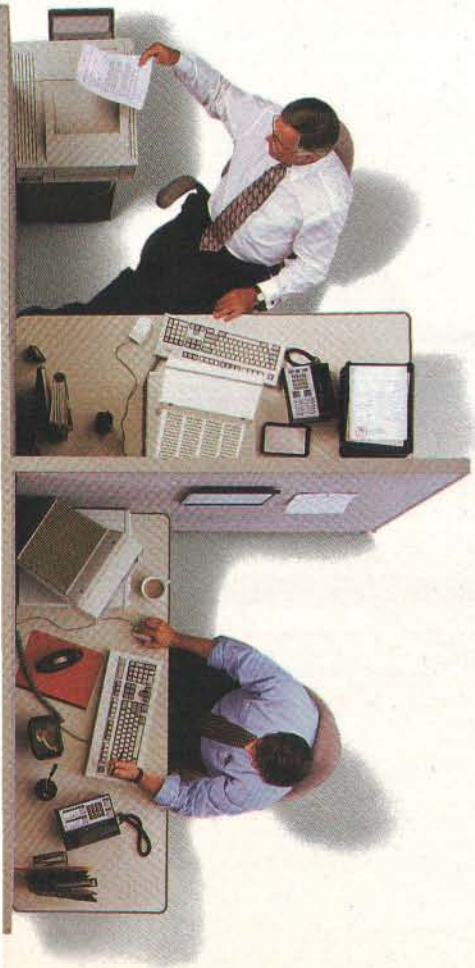

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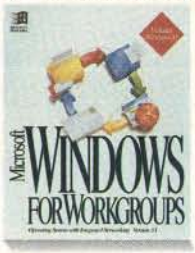

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CA), a company that used to make only Mac products, is releasing five new products for the Windows platform. Among them are a 24-bit-color accelerated-video card that uses proprietary chips originally developed for the Mac version and a relatively low-cost color-proofing system built around a dye-sublimation printer and color-calibration software. The new SuperMac products for PCs will be marketed under the SuperMatch label—not because SuperMac fears its name would deter PC users, but because the company doesn't want to upset Apple.

In other cross-platform developments, RasterOps (Santa Clara, CA) said it will incorporate Adobe Systems' (Mountain View, CA) newly announced PixelBurst graphics coprocessor in add-on boards not only for the Mac but also for PC and Sparcstation platforms. Adobe's PixelBurst, an application-specific IC that is said to accelerate high-resolution screened images up to 10 times faster than software-based rendering, will also be sold to makers of PostScript printers and imagesetters.

Adobe also revealed a joint-development agreement with Silicon Graphics (Mountain View, CA) to port Adobe Photoshop to Silicon Graphics' Unix-based Indigo RISC workstations. Adobe, which is believed to be developing a Windows version of Photoshop, plans to ship its first Unix port of the program in 1993.

—Tom R. Halfhill and Patrick Waurzyniak

Intel Introduces Speedier 486SX and OverDrive Chips

SANTA CLARA, CA—Intel has upped the ante again, introducing in September its fastest 486SX microprocessor and a new speed-doubling OverDrive chip. The new CPUs will accelerate the trend away from 386-based systems and put more pressure on Intel's competitors, who have yet to market a full-fledged 486-compatible processor.

The new 486SX is clocked at 33 MHz and is rated at 27 MIPS. That's about twice as fast as a 33-MHz 386DX. Until now, the fastest 486SX was the 25-MHz version, which delivers 20 MIPS. Intel also makes 16- and 20-MHz versions of the 486SX.

Unlike the 486DX series, the 486SX chips lack an FPU. Intel's OverDrive chips are designed to provide an upgrade path for 486SX systems. When plugged into a special socket on the motherboard, an OverDrive chip disables the 486SX and becomes the new CPU. The OverDrive is functionally equivalent to a 486DX with an FPU, but it runs twice as fast internally as the 486SX it replaces and communicates with external devices over the CPU bus at only half the OverDrive's clock rate. The OverDrive chip announced as a companion for the 486SX/33 is clocked at 66 MHz and improves performance by about 70 percent.

More than a dozen manufacturers joined Intel's introduction with announcements of new 486SX/33 boards and systems. Among them are AST, Apricot, Asustek, Elitegroup, Epson, First International, Gateway 2000, Gecco, Juko, NCR, Olivetti, Tandy, and Zeos. System prices range from $1600 to $2200.

Intel's list price for the 486SX/33 is $189 in 1000-unit quantities. That compares to $109 for the 486SX/25 and $94 for the 16- and 20-MHz versions of the 486SX.

—Tom R. Halfhill

New Interrupt Architecture Supports Multiprocessing

In October, Intel introduced a new interrupt architecture designed to improve multitasking performance and pave the way for multiprocessing operating systems, such as the unreleased Windows NT. The architecture has been adopted by major hardware and software companies and is expected to begin appearing in computers late this year or early in 1993.

At the very heart of the architecture is a new interrupt controller chip, the Intel 82489DX. It supersedes the 8259A, which made its debut in 1978 and is found in almost all PC compatibles. The 8259A has no support for multitasking or multiprocessing, although it can be tricked by software to accommodate the kind of cooperative multitasking used in Windows 3.1.

Intel says that the 8259A has been rendered obsolete by the arrival of more

NANOBYTES

Although Intel's next-generation microprocessor, the P5, won't be introduced until early 1993, there's already some intriguing talk about its eventual successor—the **P6**. This fall, Intel executive vice president Craig Barrett apparently spilled the beans on the still-secret project while talking with industry analysts. The P6 will reportedly be introduced in about 18 months and incorporate 10 million transistors. That's about three times as many transistors as the P5 has and about eight times as many as you find in the 486DX. If the 18-month projection is accurate, it would be the shortest generation in Intel's history: The 286 followed the 8086 in 44 months; the 386 followed the 286 in 44 months; the 486 followed the 386 in 42 months; and the P5 will follow the 486 in about 45 months. □

486SL-based clock-doubled OverDrives? Intel's new 486SL processor (see the cover story this month) is available in three different packages, including one that's pinless for easy insertion and removal. The pinless package drops into the equivalent of a ZIF (zero insertion force) socket. □

At CompuExpo, recently held in Las Vegas, Chips & Technologies (San Jose, CA) featured six subnotebooks in its booth as a demonstration of the various ways the PC/Chip is being used. Keynote speaker **Gordon Campbell**, CEO of C&T, said there are three trends in the processor arena: a move from monopolistic to multisourced chips, a division of the market into performance-oriented and portable-oriented architectures, and an emergence of single-chip systems that will enable new classes of end-user equipment. "Expect the retail price of single-chip systems to flatten out at $500 and [their] weight to drop below 1 pound and stay there. Expect conventional 386-type portables to weigh 2 pounds and sell for under $1000 by 1997," he said. □

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sophisticated operating systems that will allow true preemptive, multithreaded multitasking and symmetric multiprocessing. Operating systems such as Windows NT, OS/2 2.0, Solaris 2.0, NextStep 486, and Unix System V must have a more robust interrupt architecture to handle their demands. Computers that are built around the 82489DX can have as many as 255 microprocessors, each with its own interrupt controller. In a symmetric multiprocessing environment (e.g., Windows NT), the controllers automatically assign a task to the least busy processor in the system or to the processor running the lowest priority task. This ensures that processing loads are distributed equally among all processors in the system.

The 82489DX connects directly to the high-speed CPU bus rather than communicating with the CPU over the slower I/O bus, as the old controller did. Also, the 82489DX runs at 50 MHz, compared to the older chip's 8 MHz. Intel says these improvements boost performance by 5 or 6 MIPS on a 100-MIPS desktop computer or by 20 to 25 MIPS on a 100-MIPS network server (which handles many more interrupts from clients on the network). Intel says future versions of the controller will run at the same speeds as its fastest CPUs.

Companies adopting the new architecture include IBM, Microsoft, DEC, Novell, NCR, Sunsoft, NEC, Acer, AST, Everex, Olivetti, The Santa Cruz Operation, Sequent, and USL.

—Tom R. Halfhill

IBM Now Aims AIX at Commercial Markets

NEW YORK—Despite its much-publicized efforts to promote OS/2, IBM is still deeply committed to Unix, said James Cannavino, IBM vice president and general manager of the Personal Systems line of business, at Unix Expo. In fact, the company seeks to parlay its success in the technical Unix market into a leading position in what it sees as the rapidly growing Unix commercial market.

Cannavino sees the annual growth rate in the Unix market as 15 percent, twice that of the PC market and four times that of the industry as a whole. But Cannavino is taking aim at the commercial Unix market, where he says the growth rate will be even higher—17 percent.

AIX, IBM's version of Unix, runs on a wide range of platforms, from PS/2s to mainframes. But the company's strongest weapon in the Unix arena is its array of RISC System/6000 workstations and servers, which have been popular in the technical Unix market.

To bolster the system's presence in the commercial market, Cannavino announced that IBM would transplant its CICS (Customer Information Control System) transaction-processing software to the RISC System/6000 from its traditional mainframe roots. The company also introduced modular transaction-processing products that use the DCE (Distributed Computing Environment) developed by the Open Software Foundation. From now on, says Cannavino, IBM will concentrate on commercial and technical Unix systems equally.

IBM is so eager to promote AIX as a world-class operating system that it did something at the Unix Expo that would have been unthinkable just a short time ago. To prove that its version of Unix could be run on a wide range of systems, IBM showed AIX running on personal computers from arch-rivals Dell, Tandy, AST, and Compaq.

—Rich Malloy

IBM Unveils PowerPC Precursor

IBM has outlined the growth path for the single-chip version of its RISC System/6000 processor. The single-chip processor is being used in the 220 version of the IBM RISC System/6000, which has a base price of only $3750 yet reportedly delivers 27 SPECmarks. This processing chip is a forerunner of the PowerPC chip being codeveloped by IBM and Motorola. The next version of the chip, called the 601, is significantly faster than the current version and will be optimized for commercial applications.

The first versions of the 601 chip will be ready by the end of 1992. IBM and other companies will offer computers that are based on the chip late next year. In 1994, three new versions of the chip will appear: the 603, which offers better performance; the 604, which includes power management capabilities; and the 620, which will be used in symmetric multiprocessing systems.

—Rich Malloy

NANOBYTES

James Cannavino, IBM vice president and general manager of the Personal Systems line of business, says that IBM will demonstrate a version of OS/2 based on a Mach microkernel before the end of the year. The primary reason that IBM is interested in basing a new version of OS/2 on the Mach kernel, which was developed at Pittsburgh's Carnegie Mellon University, is that the kernel is open, according to one IBM official. Developers that have written programs to run on Mach-based operating systems (e.g., AIX, IBM's version of Unix) want to be able to run them on OS/2, and they can't do that on current versions of OS/2. IBM says the plan is for the Mach-based OS/2, which should be released within 18 to 24 months, to run DOS, Windows, OS/2 2.0, and Unix programs. One way to think of the new version, which might be called Portable OS/2 or OS/2 3.0, is as OS/2 with a new engine under the hood. □

Eleven companies—including Apple, Tandem Computers, BRHC U.S. West, and Kaleida Labs—have joined a consortium to investigate the extent of public demand for providing interactive multimedia technology to U.S. homes through either the TV or the PC over telephone, cable, or fiber-optic lines. □

Have you been following the emerging trend of personal computers merging with TVs? If so, you will be interested in Hewlett-Packard's latest plans for the **HP 95LX**. The company says it plans to offer a way to link its palmtop system with an interactive TV system that is produced by TV Answer, which is based in Reston, VA). □

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Electronic Phone Directory Service Comes to the U.S.

PARIS—Lucky phone subscribers in the U.S. are to get an electronic telephone directory that is directly accessible by videotex. This will be useful to microcomputer users in corporate sales and marketing departments who use database and word processing programs to launch targeted promotional mailings. With the new phone directory, direct-marketing companies should no longer have a problem acquiring a list of, say, beekeepers in the Minneapolis–St. Paul area.

The new service is the result of an agreement announced in September between BRHC U.S. West (Englewood, CO) and France Telecom. Under its official name, Teletel, the latter has pioneered the use of videotex on a mass scale in France, where more than 6 million Minitel terminals are supplied free to users.

For its part, the French electronic-directory service supports 10,000 simultaneous accesses. With its 50,000 daily updates of over 26 million records, the Teletel transactional database is claimed to be the largest of its type in the world. The BRHC U.S. West service will initially be housed on the same database. U.S. users can either use a PC or a Mac equipped with a V.23bis-standard modem with Teletel emulation software or a Minitel 2 set that has been adapted to U.S power standards. For now, the BRHC U.S. West electronic-directory service will be limited to the Minneapolis–St. Paul area.

—Raymond Boult

Board Makers Expand Mac, Windows Video

Over the past 10 years, personal computers have proved their ability to manage data: The majority of people likely to buy a computer, especially in the business sector, have done so. Now the computer industry is anxious to attract users to computing who haven't yet seriously considered buying a PC. The attractions are Apple's QuickTime and Microsoft's new Video for Windows on the PC.

Both Apple's and Microsoft's software-only video/sound solutions are impressive technical advancements because they offer video to the broadest possible consumer base. When played without hardware acceleration, however, these video solutions make you watch digital movies through video windows that are about one-quarter the size of the computer screen.

When Microsoft introduces Video for Windows in November (see "Microsoft's Small-Screen Debut" on page 56), several familiar hardware companies will be right there with it, announcing—and in some cases already shipping—low-cost graphics accelerators that provide full-screen, full-motion color video. For example, ATI Technologies' (Scarborough, Canada) Mach 32 graphics accelerator chip, as found in the company's Graphics Ultra+ and Graphics Ultra Pro Windows accelerator cards, will offer Video for Windows users full-screen, 30-frame-per-second playback, with up to 65,000 colors at resolutions of up to 1024 by 768 pixels or 24-bit color at 800- by 600-pixel resolution. PC manufacturers like Hyundai Electronics America and Gateway 2000 plan to bundle manufacturer versions of the boards in their new PCs.

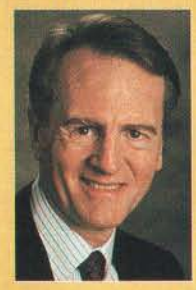
Matrox (Dorval, Quebec, Canada) is developing MGA (Multimedia Graphics Architecture) boards that can play video from NTSC or PAL sources (e.g., cameras, VCRs, and videodiscs) and convert them on the fly to support 8-, 16-, and 24-bit displays. Alain Belanger, group director at Matrox, says the company's Marvel capture and MGA graphics boards will offer video-color-enhancement technology for improving the quality of decompressed video as it plays on a PC. For users who want to do more than just play Video for Windows' movies, companies such as Media Vision (Fremont, CA), Creative Labs (Milpitas, CA), and Matrox will offer boards at various performance and cost levels for authoring digital movies on the desktop. Media Vision, whose technology is used in the Microsoft Video for Windows general-purpose codec, will likely bundle MacroMedia's Action multimedia presentation program and players that let you run movies on DOS and Mac computers with its playback/capture card, which is expected to retail for just $349.

On the Mac, companies such as SuperMac Technology (Sunnyvale, CA), New Video (Santa Monica, CA), and RasterOps (Santa Clara, CA) have developed various adapters that support full-screen, full-motion playback/capture of QuickTime movies. ■

—Dave Andrews

NANOBYTES

John Sculley, president and CEO of Apple Computer, recently spoke of the company's directions in the next 18 months. He said that Apple will add desktop servers to its product mix as it makes the transition to RISC PCs with the PowerOpen developments of IBM and Motorola.



"Pieces will be in place [from the IBM deal] over the next 18 months." Sculley said the second phase would be integrating Mac servers into higher bandwidth networks. "The message is we're moving more and more toward client-server computing, but not obsoleting older Macs," he says. □

With version 1.5 of **QuickTime**, Apple has doubled the base capabilities of its multimedia protocol to support playback rates of 20 to 30 frames per second on a Mac LC–class machine in a 160- by 120-pixel window or 10 to 15 fps in a 320- by 240-pixel window. If you have a Mac and a PhotoCD-capable CD-ROM drive, you can use any application that can open a PICT image to open and play a series of PhotoCD photographs through QuickTime 1.5. Support for embedded codecs should further expand the base of potential QuickTime users: No longer will you have to worry if people to whom you are sending a QuickTime movie have the proper codecs installed on their Macs. A new 1-bit dithering feature will let users with black-and-white screens easily play color movies.

QuickTime 1.5 will also support closed-captioned text. Apple is also close to releasing a set of DLLs that will allow users to play QuickTime movies on Windows-based machines. Apple hopes to release a QuickTime version for Windows SDK by the end of the year. ■

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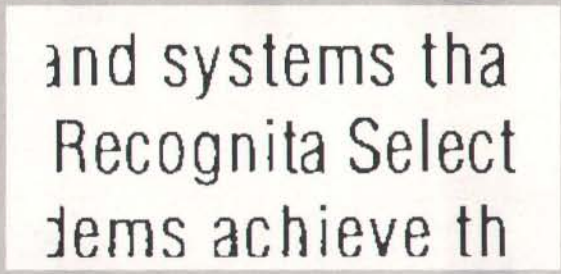

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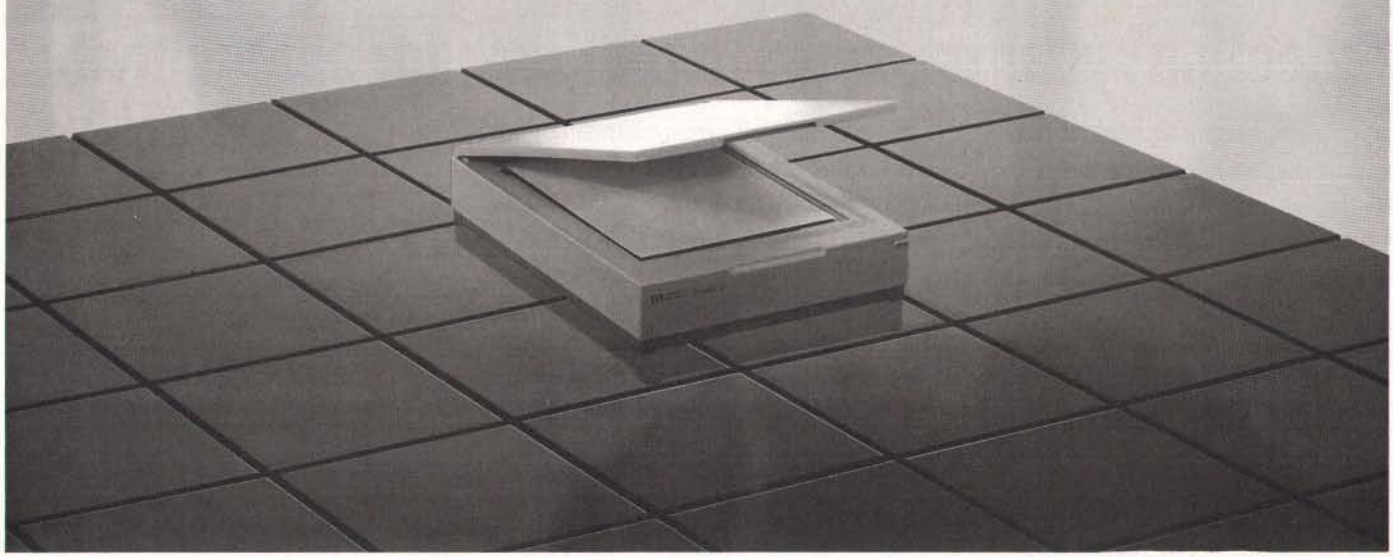

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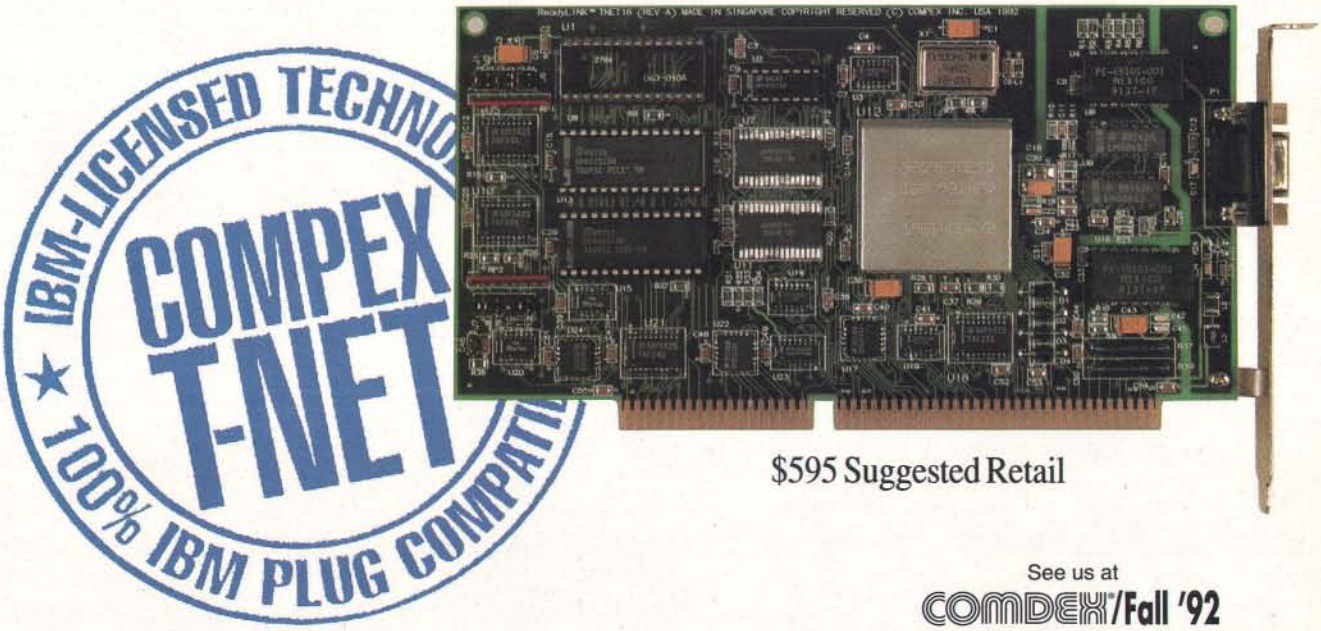

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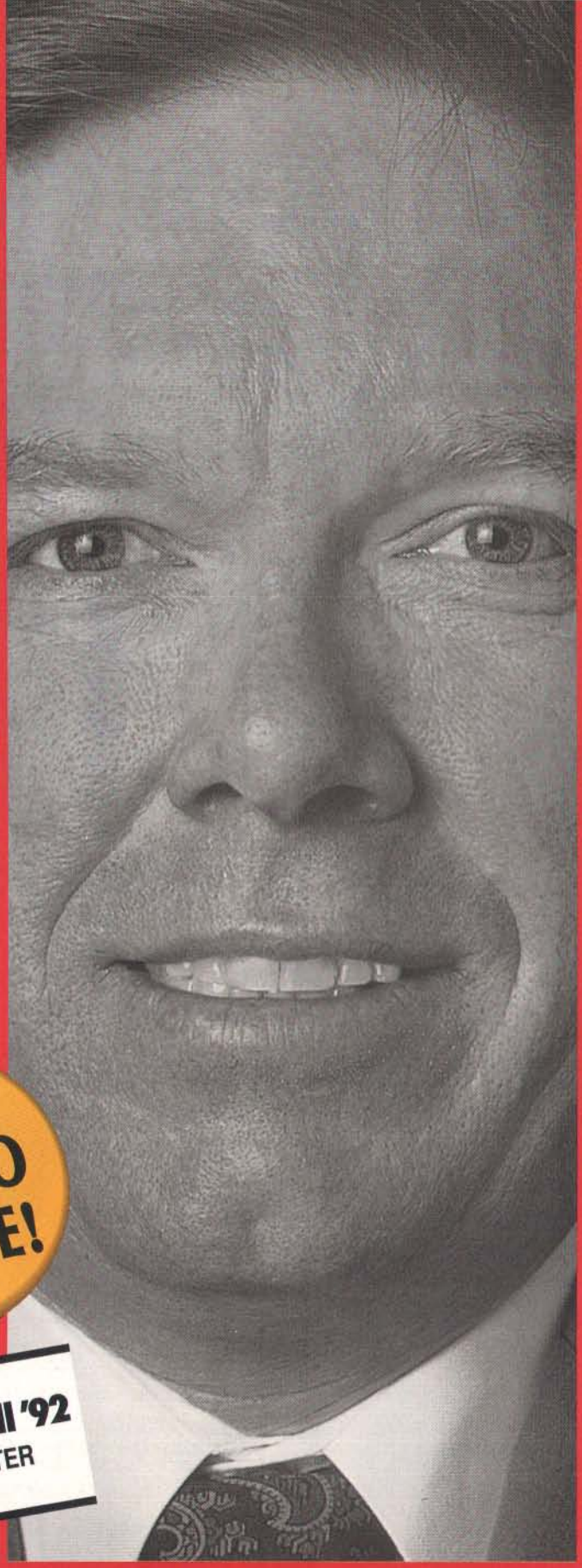

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ANDY REDFERN

COMING IN FROM THE COLD

JERUSALEM—The religious persuasion of a software developer is usually irrelevant in the marketing of a product in Europe or the U.S. But in the Middle East, careful consideration of the cultural image you present is crucial. Computers, politics, and religion may be oceans apart in some places, but here politics and religion often influence decisions before anything else. That, however, may be slowly changing.

As an example of how religion may influence computers, consider Iran, perhaps the most sensitive of all Middle Eastern countries. An Apple dealer in Iran was forced to modify the familiar Apple logo to a whole green apple: There was a fear that the traditional Apple logo with the bite missing was an unfortunate reminder of the story of Adam and Eve bringing sin into the world through the tree of knowledge.

Many Israelis take a more pragmatic and even lighthearted view of computers, politics, and religion. As we drove from Jerusalem Airport to Jerusalem, Ben Gruber, the director of the local Apple Center, laughed as he explained that the same journey on the Sabbath was doubly dangerous. "You get stoned by the Palestinians as you cross the Intifada, and by the religious Jews as you drive through Jerusalem."

The Israelis have become sensitized to the concerns of the countries around them. Of course, they have to be. The indigenous Israeli computer market is small—after all, the Israeli population is just 4 million—and software developers need to look to overseas markets to make the development cost effective.

One of the best markets is right next door in the various Arab countries. Hebrew and Arabic share some common features (e.g., reading from right to left). Thus, creating an Arabic version of a Hebrew product is a relatively simple task.

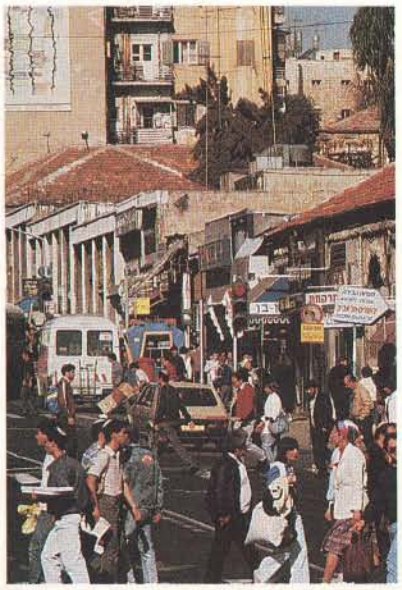
But selling software with an Israeli address in an Arab nation would be ill-advised even for the most progressive of companies. They therefore must practice sleight of hand. One Israeli company (which asked to remain nameless for obvious reasons) develops one of the leading pieces of Arabic software, but it uses an overseas office to supply the software.

Many overseas companies are more direct in their dealings with Israel and eager to invest in its technology. The investment is obvious when you realize that Motorola is the fifth biggest electronics company in Israel and Intel comes in a creditable ninth.

But surprisingly, until recently, one of the world's leading high-tech nations was missing from Israel. Japan's dependence on Arab oil had forced it to toe the Arab League's Israeli boycott. However, Noam Eshkol of the Israeli Export Institute believes that, since the Gulf War, the Japanese are finally coming. "In the last year, we have seen a dramatic increase in the numbers of Japanese companies arriving in Israel," he says. And they're not here to sell—they're here to buy Israeli high-tech skills.

Combining high-tech skill with marketing sleight of hand creates a perfect breeding ground for high-tech trickery. Illegal software copying in Israel is rife. At least four of the world's computer viruses and some of the world's more infamous hackers have emerged from Israeli universities.

As Middle East tensions wane, Israel can sell its high-tech wares more openly



Yanki Margalit believes that this places Israeli virus- and copy-protection software at the technological forefront. His company, Aladdin Knowledge Systems, has produced more than 350,000 dongles in seven years and claims that almost 80 percent of the software sold in Israel is protected. His eyes light up as he fingers one of his dongles and explains the ingenuity that is required in beating the software thieves: "We always have to innovate to beat the hacker, especially in this country." His techniques include modifying interrupts and creating write-only code, and even self-modifying code, just to beat the ingenious pirate.

A new hope appears to be dawning in Israel. The slowly emerging peace is bringing economic dividends to Israel, especially to its high-tech industry.

Although it is still perhaps far off, someday it may be possible for a computer product to be judged not by its country of origin, but solely by the ingenuity of its design and the quality of its implementation. Maybe that day will come sooner than we think. ■

Andy Redfern is BYTE's U.K./Europe bureau chief based in London. You can reach him on BIX as "aredfern."

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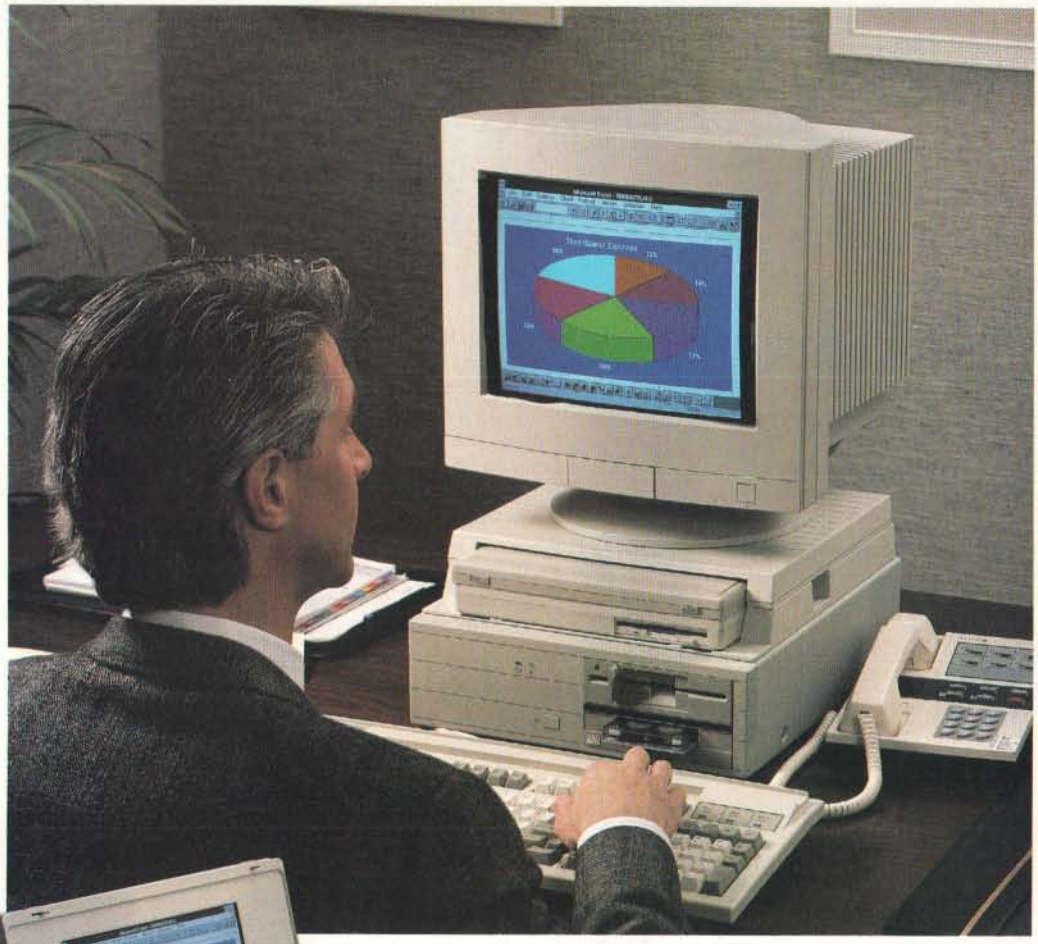
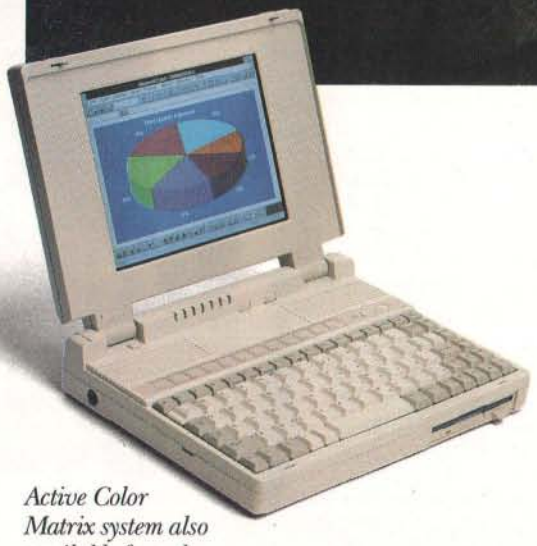
Single System.





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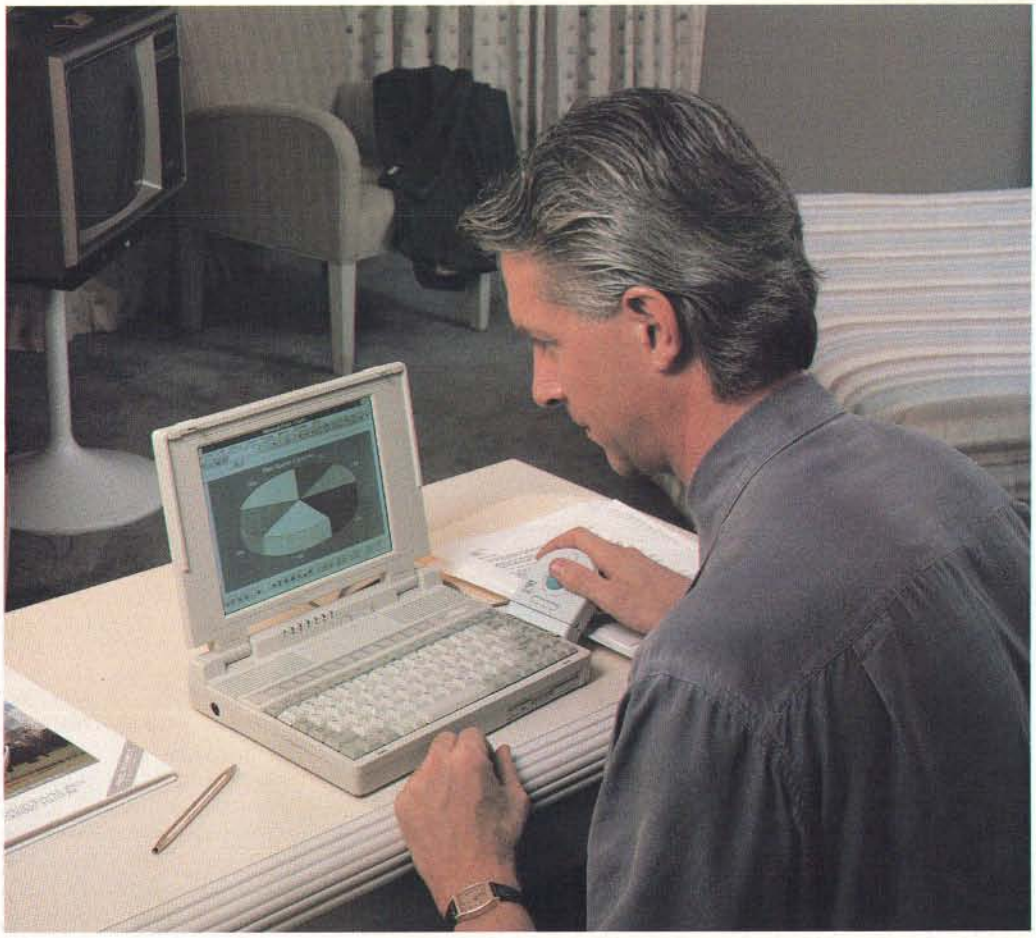

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New Macs for the Desktop and Road

TOM THOMPSON

Apple rolls out inexpensive desktop systems, beefed-up notebooks, and its first notebook/docking station

To stay ahead of the pack in the highly competitive personal computer market, Apple is updating its computers and introducing new ones as rapidly as possible. Apple is beefing up the aging Mac II line with two new members: the Mac IIvi and IIvx. The notebook line is gaining the PowerBook 160 and 180. Finally, two other Macs, the PowerBook Duo 210 and 230, are fresh on the scene. *Duo* comes from their dual personalities. Alone, they act as 4½-pound notebooks. When parked in a unique docking station, however, they function as desktop computers. These six new Macs come with System 7.1, a significant revision of System 7.0 that supports the new computers and manages 2-byte foreign-language typefaces.

New Members of the Mac II Family

The Mac IIvi (available only overseas) and IIvx share a IIci-style chassis, a 68030 CPU, a SIMM socket for ROM upgrades, three NuBus slots, the usual I/O ports, and built-in video. The Mac IIvi operates at 16 MHz, and it has a socket for an FPU. The IIvx's CPU and 68882 FPU are clocked at 31.3344 MHz, and the unit has a 32-KB on-board cache of 25-nanosecond SRAM (static RAM). (See the table for further feature information.)

If you ignore the new systems' different processor speeds, much of this hardware seems like a 25-MHz Mac IIci, but there are differences. These new Macs have a metal housing that can support the weight of a 16-inch monitor. They also have a larger power supply (112 watts) to run half-height 5¼-inch SCSI peripherals (e.g., a CD-ROM drive) that might occupy the big bay at the machine's front. An internal bay accommodates smaller 3½-inch SCSI peripherals.

The main logic board has 4 MB of RAM, and you can expand memory up to 68 MB. The ROMs are 1 MB. The IIci's PDS (Processor Direct Slot) cache slot has become an accelerator slot in these computers. It's missing the cache-control lines found in the IIci's PDS slot, but all the processor bus signals are there, so you can plug the accelerator board into it.

The circuitry in the IIvi's and IIvx's built-in video recognizes 12- to 14-inch monitors and is capable of supporting 16-bit-deep displays when you upgrade video memory. The video screen's frame buffer occupies dual-ported VRAM (video RAM) rather than residing in main memory.

Sound capabilities on the IIvi and IIvx are provided by a modified Mac LC ASIC (application-specific IC), rather than the Apple Sound Chip found in the IIci. The ASIC handles sound input and output, and the sound circuitry musters a respectable 7.1-kHz range at a 22-kHz sample rate. Finally, like the video frame buffer, the sound buffers live in VRAM, an arrangement that eliminates a performance hit when sounds are played.

Next-Generation PowerBooks

The PowerBook 160 and 180 both use the proven PowerBook 140/170 design, which

The Mac IIvx, IIvi, and the Duo Dock (inset).

consists of a clamshell housing with a 68030 CPU, a built-in trackball, an army of I/O connectors, and a SuperDrive floppy drive. The usual microphone jack for sound input is present, and there's also a built-in microphone near the hinge that fastens the LCD screen to the computer.

As do their predecessors, the PowerBook 160 and 180 weigh 6.8 pounds. Apple equipped each with 4 MB of PSRAM (pseudostatic RAM). The PowerBook 160 has a 25-MHz 68030 CPU and no FPU; it uses 80-ns PSRAM. The 180 has a 33-MHz 68030 CPU and a 68882 FPU; it uses 70-ns PSRAM. For sound generation, they use the Enhanced Apple Digital Sound Chip, which provides an 11-kHz frequency range.

Memory on the new PowerBooks is expandable to 14 MB, up from the 8-MB limit imposed by the previous design. If you simply can't fit your files on an 80-MB SCSI hard drive, a 120-MB version is available. The 10-inch-diagonal backlit LCD screens, engineered to be brighter with more contrast, support 16 levels of gray. The PowerBook 160 uses a supertwist LCD screen, and the 180 uses an active-matrix LCD screen. If you take your presentations on the road, a built-in video port at the rear of the computer drives 12- to 16-inch color monitors.

The PowerBook system software boasts some improvements as well. You can set the backlight to automatically switch off when the PowerBook sits idle for a certain time interval, extending battery life. The neatest system software feature isn't new, however, coming from the low-end PowerBook 100: A Control Panel lets you assign the SCSI ID of the PowerBook's main logic board. With the proper SCSI cable, this lets you mount the PowerBook 160 or 180's hard drive as a volume on your desktop Mac to easily move massive amounts of data between your desktop computer and the PowerBook.

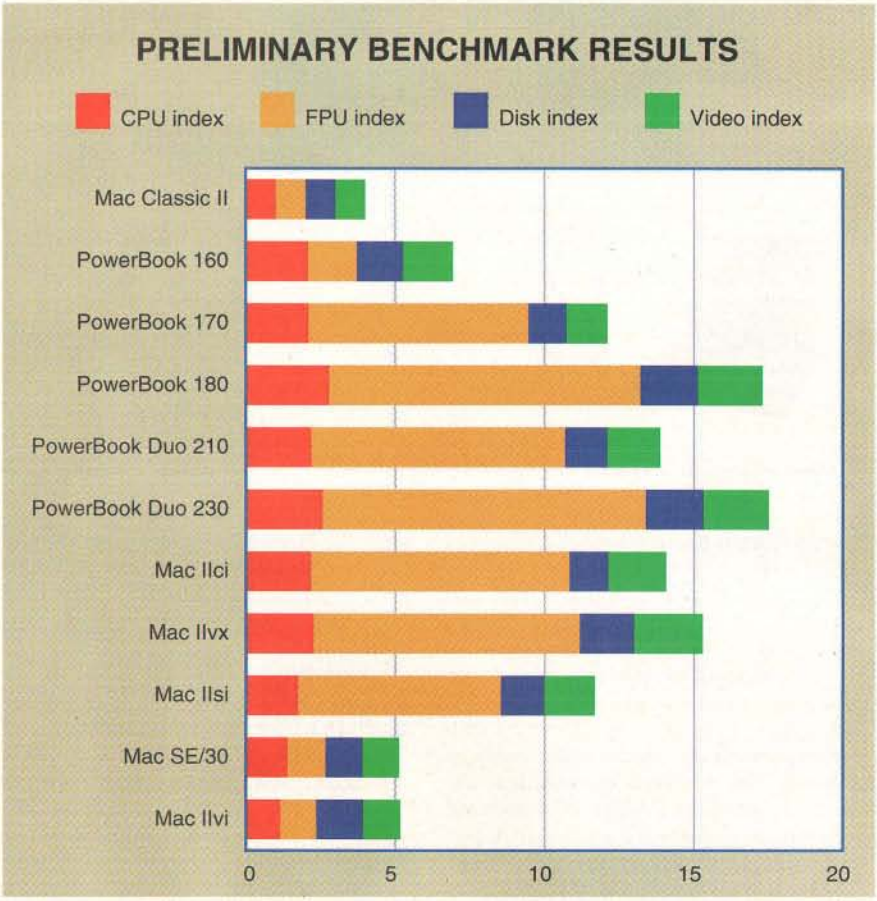
Is It a Notebook or a Desktop?

Although it's nice to talk about exchanging files between an office Mac and a PowerBook to let you work on the road, the reality is that some of us can't afford two computers. Apple's answer for this is a new line of computers: the PowerBook Duos. These powerful yet lightweight notebook computers are designed to operate either stand-alone or inside a docking station called the Duo Dock. The Duo Dock provides ample expandability and resources, while the PowerBook Duos pack enough horsepower to function as desktop computers.

The PowerBook Duo line comes in two versions: the PowerBook Duo 210, with a 25-MHz 68030 CPU, and the Duo 230, with a 33-MHz 68030 CPU. The Duos are small, dark slabs just 1.4 inches thick and weighing only 4.2 pounds each. Apple achieved the low weight by using a magnesium frame that provides structural strength and acts as a heat sink. A smaller, recessed trackball helps achieve the computer's low profile. Nickel-metal-hydride batteries provide sufficient power and should last 4 to 4½ hours.

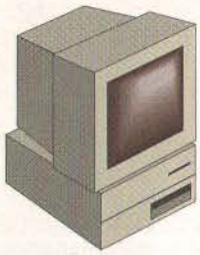
Both computers use a 9-inch-diagonal supertwist LCD screen that supports 16 levels of gray. Standard memory is 4 MB of DRAM (80 ns for the 210, 70 ns for the 230) located on the main logic board, expandable to 24 MB via a memory board plugged into a RAM-expansion connector. To add RAM, you remove the keyboard, plug the memory board into the RAM connector underneath, and replace the keyboard. There's also a modem connector for an optional internal fax modem board. Like the PowerBook 160 and 180, the Duo carries a built-in microphone on the case near the hinge.

The Duos' main logic board is packed with the 68030 CPU, 1 MB of ROM, an SRAM that stores power management code, DRAM, and custom ASICs. The main system-controller ASIC manages most I/O, the sound system, and timing. A microcontroller handles much of the power-saving operation, and a Combo chip provides SCSI and serial I/O. The



Relative subsystem performance of the new Macs. For all tests, a Classic II = 1. Higher numbers indicate better performance. The Mac IIci didn't have a cache board, and the IIsi had an FPU. Existing Macs ran System 7.0.1, while the new Macs ran beta System 7.1 software. The Duos were docked and had access to an FPU.

THE NEW MACINTOSHES BY FAMILY

	Model	Processor	Standard RAM	Maximum RAM	Slots	Ports	Dimensions (inches); weight (lb.)
	**Mac IIvi**	16-MHz 68030	4 MB	68 MB	3 NuBus	1 ADB, 2 RS-422 serial, DB-25 SCSI, sound input, sound output, video	6 × 13 × 16.5; 25
	Mac IIvx	32-MHz 68030	4 MB	68 MB	3 NuBus	1 ADB, 2 RS-422 serial, DB-25 SCSI, sound input, sound output, video	6 × 13 × 16.5; 25
	PowerBook 160	25-MHz 68030	4 MB	14 MB	Memory, fax modem	1 ADB, 2 RS-422 serial, HDI-30 SCSI, sound input, built-in mike, sound output, video	2.25 × 11.25 × 9.25; 6.8
	PowerBook 180	33-MHz 68030	4 MB	14 MB	Memory, fax modem	1 ADB, 2 RS-422 serial, HDI-30 SCSI, sound input, built-in mike, sound output, video	2.25 × 11.25 × 9.25; 6.8
	PowerBook Duo 210	25-MHz 68030	4 MB	24 MB	Memory, fax modem	1 RJ-11, 1 RS-422 serial, built-in mike, docking connector	1.4 × 10.8 × 8.5; 4.2
	PowerBook Duo 230	33-MHz 68030	4 MB	24 MB	Memory, fax modem	1 RJ-11, 1 RS-422 serial, built-in mike, docking connector	1.4 × 10.8 × 8.5; 4.2

* Prices were tentative at press time.

sound system has a frequency response of 7.1 kHz.

It's important to note, however, that there's no 68882 FPU or built-in floppy drive, and while the I/O subsystems are present, many of the ports and their interface chips are absent. These lines and CPU bus signals get routed to a covered 152-pin expansion connector at the computer's rear. The connector communicates to the docking station. Besides this connector, the only other ports are a LocalTalk port and an RJ-11 socket for a modem board. The bulk of the fax modem board's functions are implemented in software. This provides design flexibility for adding features, but it also burdens the CPU when sending a fax or data file.

The Duo Dock docking station provides what the PowerBook Duos lack. Outside, it resembles a Mac IIsi, but in front is a flat opening into which you insert the PowerBook Duo. At the rear are all those missing I/O connectors: ADB (Apple Desktop Bus), two serial, SCSI (it uses the funky PowerBook HDI-30 connector), sound I/O, RJ-11 modem passthrough, and DB-15 video. A SuperDrive floppy drive is located on the right side. Inside, the Duo Dock has a 75-W power supply, an FPU socket, and built-in video support for 12- to 16-inch monitors. You can expand VRAM to provide 16-bit color on 13-inch and VGA monitors.

The station also has two NuBus slots and room for an internal 3½-inch SCSI hard drive. The housing is reinforced with steel beams to support large monitors. Inside the Duo Dock, the expansion connector passes I/O and processor bus signals to the docking station's hardware and the I/O ports in back. The Duo Dock charges the PowerBook Duo's battery as necessary.

Putting the PowerBook Duo into the Duo Dock is as easy as placing a videotape into a VCR. First, you move the expansion connector's hood and slip the PowerBook into the docking station. As the Duo slides into the Duo Dock, it blocks an optical sensor. Two hooks come forward, grab onto holes beside the expansion connector, and haul the computer inward the last 5 millimeters. This pulls the expansion connector onto a plug inside the Duo Dock. A motorized, damped ejection mechanism gently pushes the computer

Configuration and price*
4 MB RAM/40-MB hard drive: $2600 4 MB RAM/80-MB hard drive: $2900 5 MB RAM/80-MB hard drive, plus CD-ROM: $3400
4 MB RAM/80-MB hard drive: $2949 4 MB RAM/230-MB hard drive: $3319 5 MB RAM/80-MB hard drive, plus CD-ROM: $3219
4 MB RAM/40-MB hard drive: $2429 4 MB RAM/80-MB hard drive: $2789 4 MB RAM/120-MB hard drive: $3149
4 MB RAM/80-MB hard drive: $3869 4 MB RAM/120-MB hard drive: $4229
4 MB RAM/80-MB hard drive: $2249
4 MB RAM/80-MB hard drive: $2609 4 MB RAM/120-MB hard drive: $2969

partially out of the dock when you want to remove the computer. A security key can lock the Duo Dock so the computer can't be removed.

You have two options if you need more than a LocalTalk connection or phone line while you're on the road. A PowerBook Duo Floppy Adapter provides an HDI-20 floppy drive port and an ADB port. This lets you use either a portable SuperDrive (the same one used by the PowerBook 100) or a low-power mouse with the computer.

Your other option is to get a Mac Duo MiniDock made for Apple by SuperMac Technology. It provides all the I/O ports (i.e., ADB, two serial, HDI-30 SCSI, sound I/O, and external video) and the floppy drive port. With it, your Duo practically becomes a PowerBook 160 or 180, but it still weighs less than 6 pounds, since the MiniDock weighs about a pound. Both the Duo Dock and MiniDock have configuration ROMs that describe their devices and supply driver code to the Mac OS, much as the configuration ROM on a NuBus board does. You can attach the MiniDock or Floppy Adapter and start using the devices without rebooting. The Mac Duos also have the screen-dimming and external SCSI drive features of the PowerBooks.

The Duo design has some nice touches. When you close the Duo's display, the latch sends a signal that tells the computer to go into sleep mode. If you put a sleeping Duo into the Duo Dock, a pin on the expansion connector informs the Power Manager to put up an alert dialog box telling you to run Shutdown. At the same time, the Duo Dock ejects the computer. This lets you safely dock the computer with the power off; it also makes the PowerBook Duo scan the Duo Dock's hardware and reestablish any network connections when you dock it. This same pin also informs the Duo that a MiniDock or other expansion adapter is connected to the computer.

Observations

The Mac IIvi and IIvx are welcome members to the Mac II clan. They provide new features, such as the improved built-in video with a CD-ROM drive, at a reasonable cost. In the BYTE benchmarks (see the figure), the prototype IIvi system I looked at posted about the same speed as a Mac SE/30. However, the low-level BYTE benchmarks indicate that the IIvx, which barely edged ahead of a 25-MHz IIci without a cache board, isn't as fast as its CPU clock speed might indicate.

Why is this? The explanation from Apple is that while the CPU and FPU are clocked at 32 MHz, the IIvx's main bus operates at 16 MHz, allowing the use of plentiful 80-ns RAM. Unfortunately, this also means the processor waits for memory reads and writes to complete, which degrades performance.

The PowerBook 160's and 180's screens are a marvel to behold: crisp and bright. They make the PowerBook 170's active-matrix screen look drab by comparison. The benchmark results indicate that the 33-MHz PowerBook 180 should be a powerful midrange computer. It easily fills the yawning performance gap between the 25-MHz Mac IIci and the 40-MHz Mac IIfx—something I had hoped the IIvx would do. With the built-in video port, I expect to see a lot of office desks populated with a PowerBook and a color monitor.

The PowerBook Duos are perhaps the ultimate in powerful yet lightweight Mac computing. They're 2.6 pounds lighter than the PowerBooks, but as the benchmarks show, the Duo 210 and 230 deliver the same processing punch as their PowerBook counterparts. Their weak areas are the lack of an FPU and no built-in floppy drive. This limits you only on the road, however, since the machines have access to both when parked in the Duo Dock.

The Duo Dock is perhaps the best implementation of a docking station I've yet seen. There are no cables to move, and a lot of thought has gone into making the computer's parking and removal effortless and foolproof.

The big question for potential notebook owners is whether to buy a PowerBook or a PowerBook Duo. If you need to crunch numbers or want a self-contained Mac with a floppy drive and all the I/O ports, a PowerBook is the way to go. If you're a fanatic about weight, the PowerBook Duos deliver the same performance in a lighter package. If you need a floppy drive or some I/O connections, you can use a Duo MiniDock with the computer, and the combined system still weighs less than a PowerBook 160 or 180 by over a pound. ■

Tom Thompson is a BYTE senior editor at large with a B.S.E.E. from Memphis State University. He is an associate Apple developer. You can contact him on BIX as "tom_thompson" or on the Internet at tomt@bytepb.byte.com.

THE FACTS

Mac IIvi, Mac IIvx, PowerBook 160, PowerBook 180, PowerBook Duo 210, PowerBook Duo 230

Options:
Mac Duo Dock, $1079; Mac Duo MiniDock, $589; PowerBook Duo Floppy Adapter, $135

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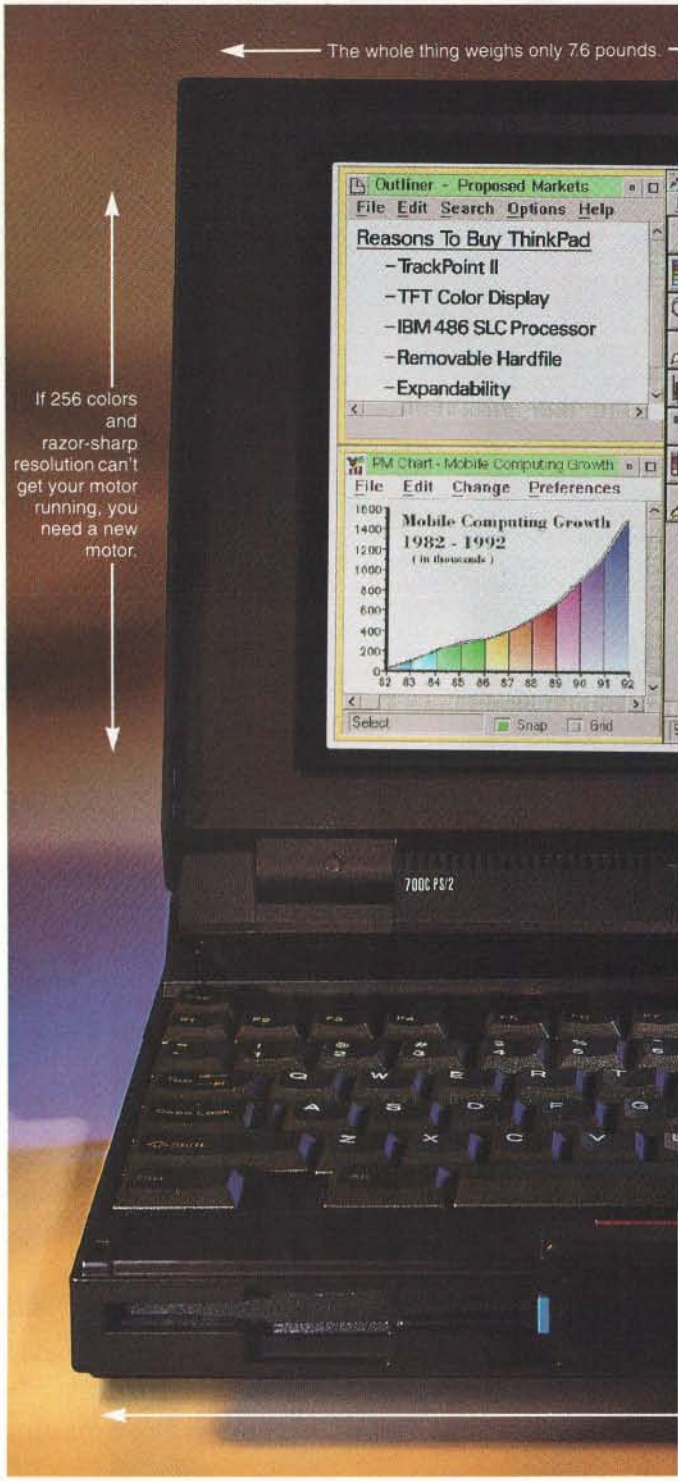

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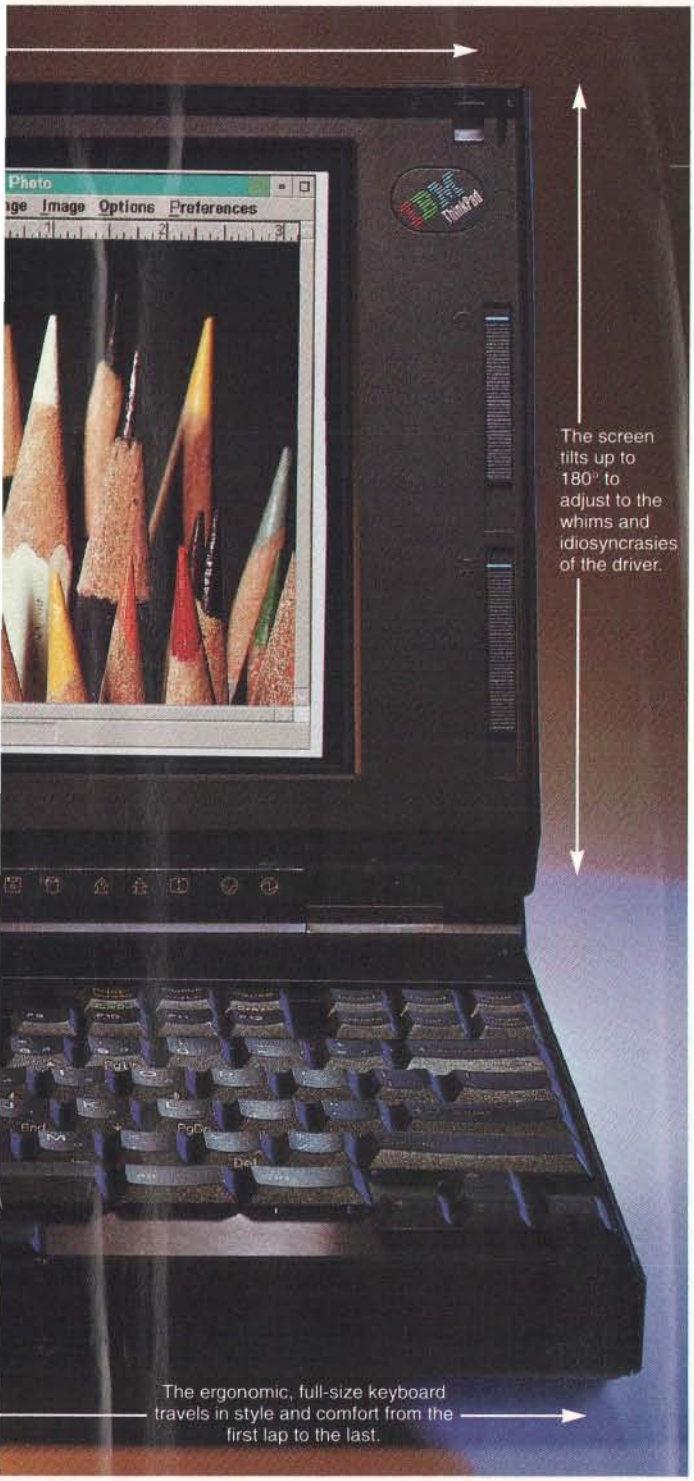
Its father wa



of memory upgradable to 16MB. 120MB of hard disk space. Pre-installed DOS 5.0 and PRODIGY.® You can soup it up with a turbo-charged 486SLC2 50/25 MHz processor—just one of the upgrade products IBM offers. And the hard disk is removable, so it's easy to upgrade and share your ThinkPad, not to mention the great security and virtually unlimited storage.

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Battery Life*	2–4 Hours	3.8–7.5 Hours
Weight	7.6 Lbs. with Battery	6.5 Lbs. with Battery
Warranty	3 Years (International)	3 Years (International)
Price**	$4,350	$2,750

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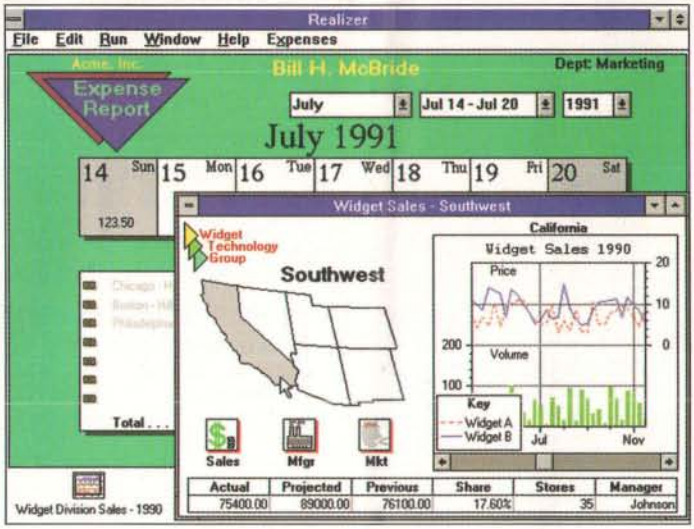

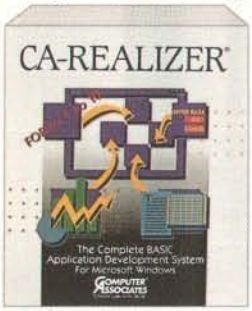

Once an application is complete, you can compile it into a stand-alone Windows application and distribute it royalty-free with the run-time module that's included. And you can generate an installation disk with the push of a button.

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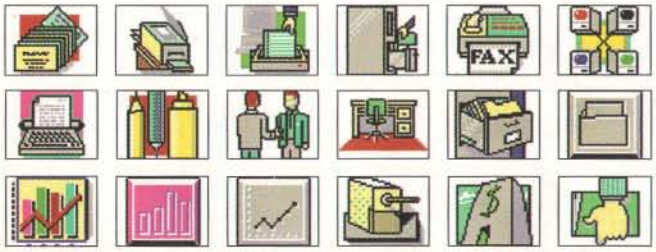

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Microsoft's Windows Database

JON UDELL

SQL and ISAM data meet Visual Basic in Access, Microsoft's powerful new database tool

Microsoft's long-rumored Windows database has finally arrived, and it's been worth the wait. In brief, Microsoft Access is a marriage of SQL (Structured Query Language) and Visual Basic, and it's a happy union.

The Access development environment is a tour de force of user-interface design. MDI (Multiple Document Interface) child windows contain multiple active tables, forms, and reports. The object editors and subeditors manage hundreds of properties cleanly, offering drop-down lists of valid options wherever possible. You can hop instantly between design and execution modes using toolbar buttons. Drag-and-drop opportunities are pervasive. And intelligent assistants help you create standard forms and reports, specify visual motifs (e.g., chiseled or embossed), and populate them with database fields.

In Access, you can program on two levels: macros or an embedded language called Access Basic, which extends Visual Basic in several ways. Access Basic's new data types include tables, queries, forms, and fields. It also adds some handy features not in the current version of Visual Basic: variant data types that convert between strings and numbers as needed, group property assignment for multiple selected objects, and listboxes that you can populate by means of user-defined callback functions.

Because macros and Access Basic functions can call each other, there are always several approaches to any programming problem, which is a good thing. However, I found that the two languages can differ subtly in how they interact with data and user-interface objects. Understanding the best uses of each will take time, although it's clearly a key to proficiency with Access.

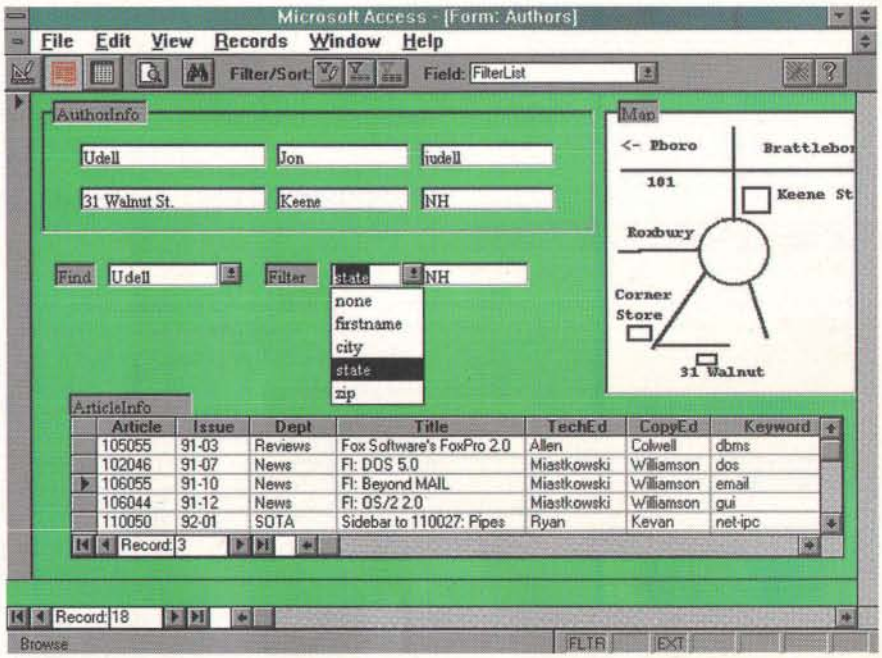
SQL Without Programming

Although it speaks a SQL dialect natively, you'll have to go out of your way to find a SELECT or UPDATE statement. Access wraps a rich set of table, query, form, and report objects around its SQL. Using these alone—without any programming—you can cover a lot of ground.

Consider my test application (see the screen). It relates a parent table of authors to a child table of articles through an intermediate table that handles the many-to-many relationship of authors to articles. Access can enforce referential integrity, and I exploited that feature to ensure that the intermediate table would reject entries containing authors or articles not present in their respective primary tables. The author table includes a whimsical map field with an active OLE link to a Paintbrush bit map. Both tables feature VCR-style controls. They are fully editable and lock automatically in multiuser mode. The find drop-down listbox presents a picklist of authors, and the filter drop-down listbox offers a list of fields available for filtering. All this took zero lines of code.

Like most SQL databases, Access maintains a single disk file per database, storing multiple tables within that file. It's not a database server, however. In a multiuser situation, each Access client must fetch records from shared storage and process them locally.

continued



Little or no programming yields impressive results, thanks to the rich set of objects available to the Access developer.

With the Open Database Connectivity driver, though, you can connect Access to remote SQL servers. The beta version of Access I tested came with the generic Windows ODBC driver and an ODBC setup script for Microsoft's SQL Server. Installing the Windows driver makes Access (or any ODBC-aware Windows application) a potential client of SQL Server (or any ODBC-aware SQL data source). Running the SQL Server script adds the necessary stored procedures on the server side and drives the golden spike.

Access can attach and work with Paradox, dBase, and Btrieve files. (FoxPro support is in the works, but it won't be available when Access ships.) Access includes engines that understand Paradox, dBase, and Btrieve engines, and it will maintain foreign indexes in place. That means that Access and, say, Paradox can enjoy live multiuser access to shared files. Access's update capability will also be a great enhancement to products such as Btrieve and FoxPro.

Although it lacks FoxPro's blazing speed when querying single tables, Access holds its own, and it really cranks through multitable queries. Queries continue to run in the background even as you're editing the first screenful of data—a real productivity boon. Access is simply a tremendous piece of work. Multiuser relational database programming for Windows remains a daunting task, but I can't think of a better tool for the job.

Jon Udell is a BYTE senior technical editor at large. You can contact him on BIX as "judell" or on the Internet at judell@bytepb.byte.com.

THE FACTS

Microsoft Access
$695

System requirements:
A 386 or higher with DOS 3.1 or higher, Windows 3.0 or higher, 4 MB of RAM, and 10 MB of available hard drive space.

Microsoft Corp.
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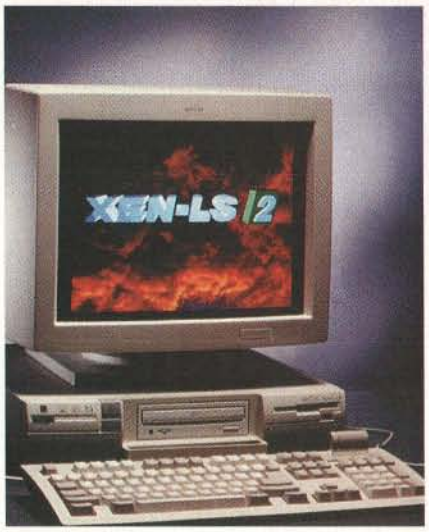
Apricot XEN-LS II Adds Multimedia Value



GLENROTHES, SCOTLAND—According to an old English saying, nothing is a bargain if you didn't need it in the first place. In these times of acute recession, multimedia has been hyped mercilessly as the future of computing, giving suppliers something to do with available computing power. This is the approach that Apricot Computers seems to have taken with its **Apricot XEN-LS II**, a multimedia station that brims with added value—value, that is, if you need it.

The XEN-LS II is designed like a PC buyer's Christmas stocking. It's packed full of everything you could possibly want: Apricot's proprietary LOC Technology security features, plug-and-play networking, professional audio (it's equipped with a CD-ROM drive, stereo speakers, and a software mixing desk), and large amounts of memory and storage space. The question, however, is, will people buy a system with so many extra features when their value remains unproven?

The XEN-LS II we looked at was a 66-MHz 486DX2-based machine with 16 MB of RAM, a 200-MB hard drive, and a high-resolution Super VGA 17-inch color monitor. The system unit is a wide, low-slung charcoal gray box. On either side sit speakers (with volume control). Floppy drives are fitted snugly above the speakers. In the center of the plastic facade is a drawer that protects the optional CD-ROM drive.

The professional audio capabilities qualify the XEN-LS II as MPC compliant—that is, in line with the specifications laid down by a group of manufacturers, led by Microsoft, that make up the MPC consortium. Apricot has been more realistic than the group about the power requirements of the base system. The XEN starts with a 486SX/25, rather than the MPC-standard minimum of a 16-MHz 386SX.

The configuration we tested costs £3825 in the U.K. Given that the average price of other reputable 66-MHz 486DX2 machines has fallen to around £2000, this is a steep price for the added hardware and software. Value aside, this system is impressive. It accepts sound input from five sources: external microphone or system, the MIDI interface, audio signals from PC applications, and the internal CD player and FM synthesizer. It allows playback of separate sound streams, too: Add a sultry voice-over to background music, for example. The system software includes Microsoft's Windows for Workgroups, so if you have another machine, an Ethernet cable is all you need to build a network.

The networking features are based on an Intel 596 Ethernet coprocessor. In conjunction with Apricot's local-bus technology, it speeds performance by intelligently routing network I/O tasks away from the main processor. Apricot is one of the first vendors to build the Intel Ethernet coprocessor onto the motherboard.

Multimedia will no doubt come into its own when companies, particularly within Europe, are confident enough to invest in hardware and software development. But the average computer buyer is still going to check every item on the features list to see whether it's necessary and whether he or she can buy it for less elsewhere. The XEN-LS II is a great machine, but it may offer more than most users need.

—Louise Cole and Andy Redfern

THE FACTS

Apricot XEN-LS II
with a 486DX2/66, 16 MB of RAM, a CD-ROM drive, a 200-MB hard drive, and a 17-inch color Super VGA monitor: about $6500 (£3825)

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Microsoft's Small-Screen Debut

On the Mac, QuickTime has turned multimedia from a hollow buzzword to a vibrant technological frontier. QuickTime's most visible contribution is a standardized scheme for capturing, storing, and playing back digital full-motion video. Microsoft has finally taken the wraps off its answer to the video component of QuickTime: **Video for Windows.**

Video for Windows, formerly known as Audio-Video Interleaved (AVI), is a software module that plugs into Windows 3.1. Like QuickTime, it creates a hardware-independent foundation for full-motion video. The beta version of Video for Windows I looked at included drivers for a handful of video-capture boards. I used the Video Blaster from Creative Labs installed in a Uniq-486/50. The video was brought in from a Panasonic AG-7650 Super-VHS industrial VCR and a Sony V-deck computer-controllable Hi8 VCR.

Video for Windows installs through Windows' loadable driver mechanism. It's unclear what form the software will take when it ships, but the beta version included an automated installation procedure that set up all of Video for Windows' components. Video for Windows includes an MCI (Media Control Interface) driver that adds the AVIvideo media type to Windows' multimedia extensions. MCI provides the Video for Windows programming interface, using simple commands such as `open`, `play`, and `seek` to control the playback of video files.

Microsoft provides a fairly capable capture program, VidCap, in its package. VidCap shows the flexibility of the system underneath it and provides a remarkably broad range of choices that lets you tune the ratio between quality and storage space. You can set audio parameters as you would in any Windows 3.1 audio program; you can choose 11-, 22-, or 44-kHz rates, in 8 or 16 bits and in mono or stereo, for each new capture you do. Similarly, you can set the video-capture frame rate, resolution, and bit depths (i.e., 8, 16, or 24 bits per frame) before you start to record. Freshly captured files are recorded raw, with no compression.

Video for Windows processes 8-bit video using an interesting palettizing scheme. Incoming video is instantly matched to a user-defined palette. You can load and save palettes by name. The default palette displays captured video in shades of gray. You can set the number of colors occupied by the video, so you can leave room in the palette for other Windows applications. A palette is attached to a captured clip, either by loading it from disk or by running a special palette-capture function that builds a palette by analyzing a series of captured video frames.

This is a good approach. If you want your palette to be dominated by flesh tones, you can select a portion of your video that primarily features people's faces. What VidCap can't match directly in the palette you select, it approximates with dithering.

Raw AVI files can be compressed after the fact by firing up Microsoft's video editor, VidEdit. The beta kit included a set of software-based compression algorithms. Like other elements of Video for Windows, the software compressors are supremely tunable, letting you target a specific data transfer rate to cover fast and slow hard drives and CD-ROM drives. For some of the compressors, a sliding scale lets you set the relative video quality. Lower quality settings negatively impact the video's appearance.

VidEdit's compression interface (see the screen) is unique: It puts up a preview window that lets you see a continuously updated video frame (which you select) that is run through the compressor in response to changes in the compressor settings. Once you tune the compressor, VidEdit reinterleaves and compresses the data, showing each frame as it's compressed. In addition to compression, VidEdit handles rudimentary cut-and-paste editing. It's miles below Adobe Premiere, but it's good enough to illustrate Video for Windows' capabilities.

The inevitable tendency is to compare Video for Windows to QuickTime, especially since Apple plans to get QuickTime running under Windows. Compared to QuickTime on the Mac, I think Video for Windows looks better. What gives Video for Windows an edge is the multimedia infrastructure it plugs into. Windows' multimedia extensions provide developers with a unified programming interface to digital audio, MIDI, CD audio, animation, video overlay, external video device control, and now digital video. On the downside, Video for Windows retails for $199, whereas QuickTime is part of the Mac's system software.

With Video for Windows, Microsoft closes the gap that once made Windows a second-class multimedia environment. The real measure of its future success will be the speed with which vendors move to implement it in their software. If Apple's experience with QuickTime is any indication, you'll be seeing a lot of digital video on Windows desktops soon.

—Tom Yager

THE FACTS

Video for Windows
$199

System requirements:
A 16-MHz 386SX or higher with a multimedia PC audio board, an 8-bit or greater VGA board, and a large hard drive or CD-ROM drive. Video capture and playback require a 33-MHz 386 or higher with a video-digitizing (or capture) board and Windows 3.1.

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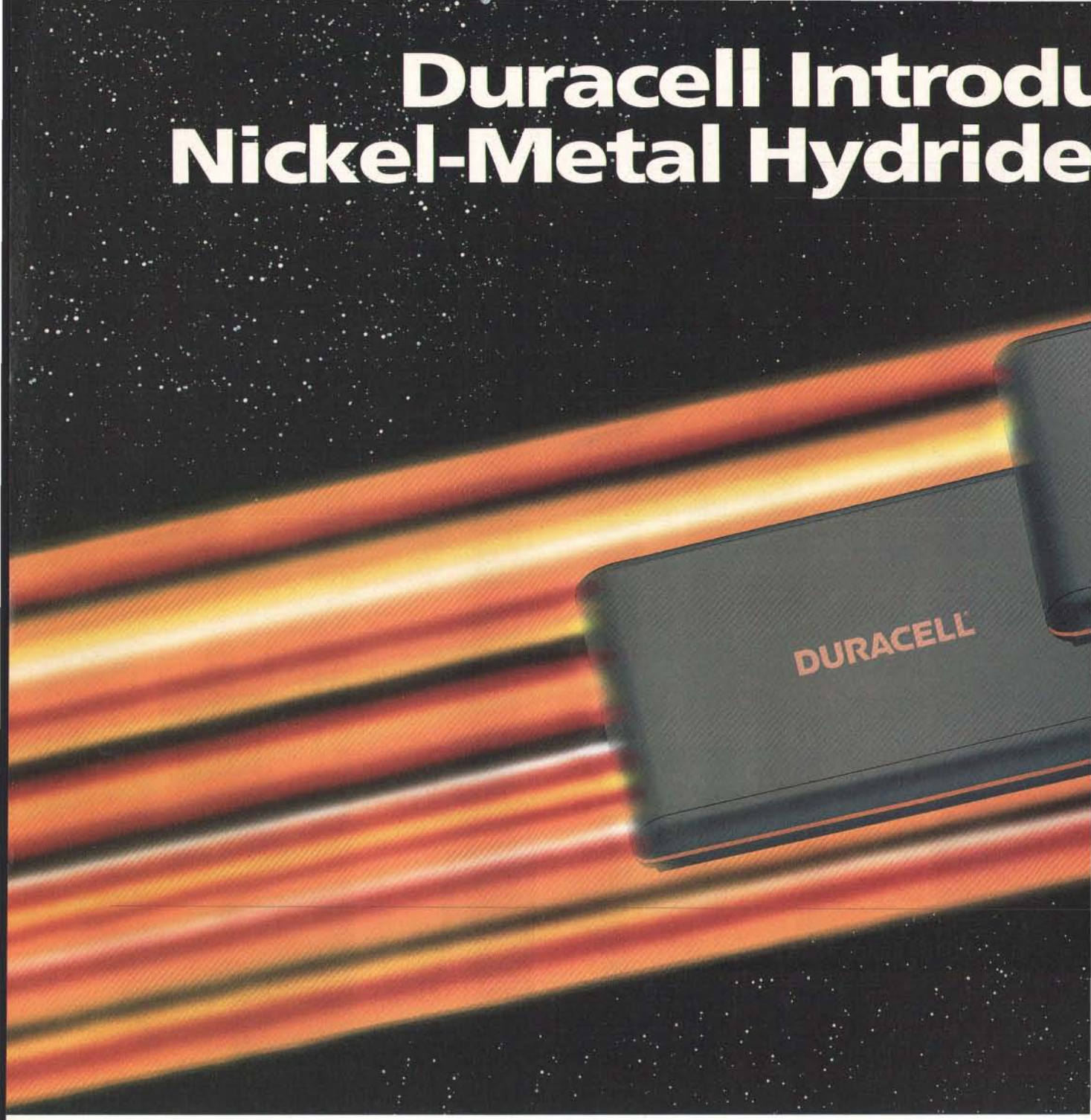

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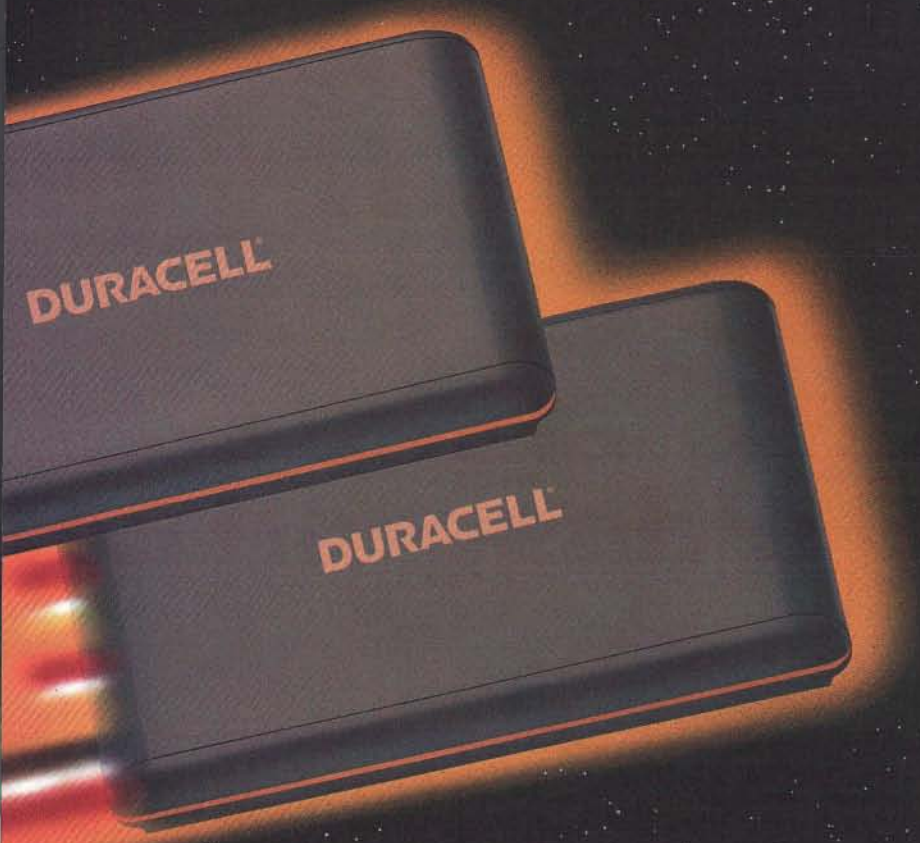

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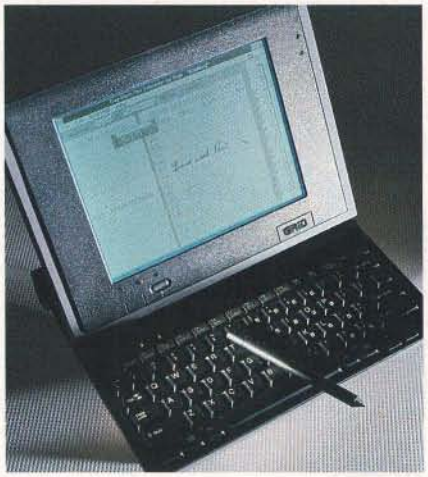
Is It a Penbook or a Notebook?

With the failure of Momenta earlier this year, the wisdom of adding pen functionality to a notebook PC has been called into question. Was Momenta's design wrong, or is there simply no demand for pen-based notebooks? Grid Systems is about to answer these questions with its **Convertible** pen-based notebook, which I have been using in its preproduction form.

A brief examination of the Convertible reveals just how compromised the Momenta design was. At first glance, Grid's system looks similar to many of the vertically oriented pen systems (e.g., the NCR 3125). It's an 11½- by 9¼- by 1½-inch, 5½-pound tablet that you can cradle in your arm. Press two tabs on either side of the unit, and the screen lifts up and tilts to a viewing angle, revealing a keyboard underneath (see the photo).

In contrast, Momenta's design was bigger and heavier than most notebooks. It used a separate keyboard and required a custom-made carrying case to transport it. The capper was that it was priced high at nearly $5000. It made trade-offs to the point where it was neither an adequate pen system nor a usable notebook PC.

Grid seems to have found a middle ground with few compromises. Powered by a 25-MHz Intel 386SL, the Convertible comes standard with a 120-MB hard drive, 2 MB of RAM, a PCMCIA 2.0 slot, and a 387 math coprocessor. The VGA video is backlit. The machine is ruggedly built—a Grid hallmark—with a tempered-glass screen overlay and magnesium case. Windows for Pen Computing is standard.



Grid sacrificed a few keys on the keyboard. The most important ones are the cursor-control keys (i.e., PageUp, PageDown, Home, and End), although those functions are accessible by two-key combinations. The floppy drive is an external unit. Claimed battery life is a subpar 2½ hours. The most important trade-off, however, is the price. Although Grid had not released pricing information as of this writing, the company said that the Convertible would be about $500 more than its Model 1660 notebook, which sells for about $3000.

You can get equivalent notebook functionality, sans pen input, for about $1500. You will pay roughly $3000 for a similarly configured pen system. Assuming you need both pen input and a fully functional notebook, the Convertible represents an estimated savings of $1000.

Grid says the Convertible is "the first pentop for everyone." The company is hoping to profit from the established base of Windows users and the anticipated introduction of Windows applications adapted for pen input.

Putting a dollar value on the added functionality is difficult. You have to consider not only the additional cost of the hardware, but also the cost of the pen-enabled software. It's unlikely that notebook users will make the investment just to have the convenience of a pen device. First-time buyers or users looking to upgrade, however, might find pen capability compelling if the trade-offs are few. For notebook users already considering a pen device, the choice is clear. Grid offers the best choice to date for combining the world of the pen with the world of the notebook.

—Michael Nadeau

THE FACTS

Convertible
Price not available at press time.

Grid Systems Corp.
47211 Lakeview Blvd.
Fremont, CA 94538
(800) 222-4743
(510) 656-4700
fax: (510) 683-0902
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Deep Purple Fire

Silicon Graphics, Inc., began showing up at Macintosh trade shows a few months ago. As one SGI representative explained: "We believe Mac users are interested in the best level of technology rather than the least common denominator." SGI is trying to make the Indigo appealing to the Macintosh community. You can expect popular Mac desktop publishing products (e.g., Adobe Illustrator and Photoshop) to become available for SGI systems. These applications stretch the Mac to its limits, but imagine them running on a relatively low-price, high-performance graphics workstation such as the Iris Indigo.

Now, thanks to SGI's **R4000 upgrade** for the R3000-based Iris Indigo, you can get an even better price/performance value. You can power your Indigo with the same processor as the one in SGI's Iris Crimson (see "First of the Red-Hot R4000s," July BYTE)—the 64-bit superpipelined Mips R4000SC. Even though SGI isn't the first Unix company to try to tap the Mac market, it may be the most likely to succeed, because it has already established itself for superiority in graphics performance.

Before I powered up the 64-bit Indigo, the only distinctive features I noticed were the little red R4000 snap-on hood ornament and a daughterboard (with a monstrous heat sink) mounted on the CPU card.

continued

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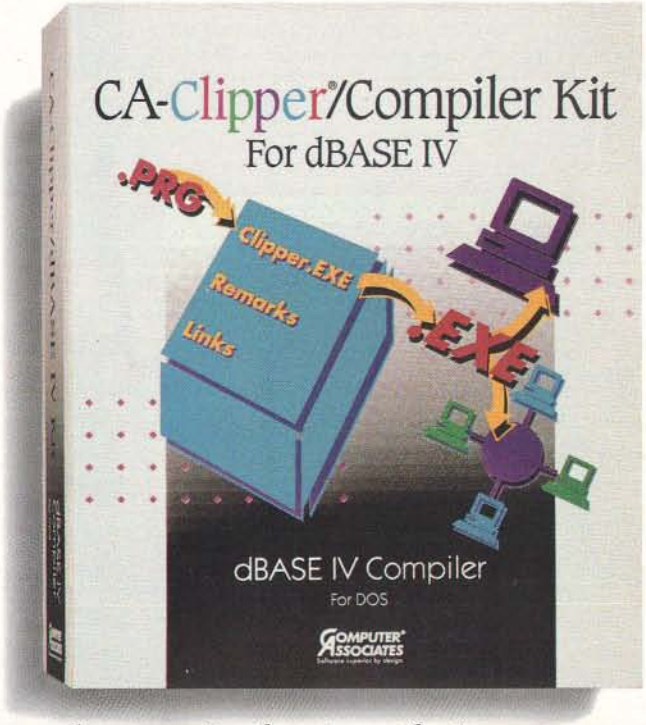

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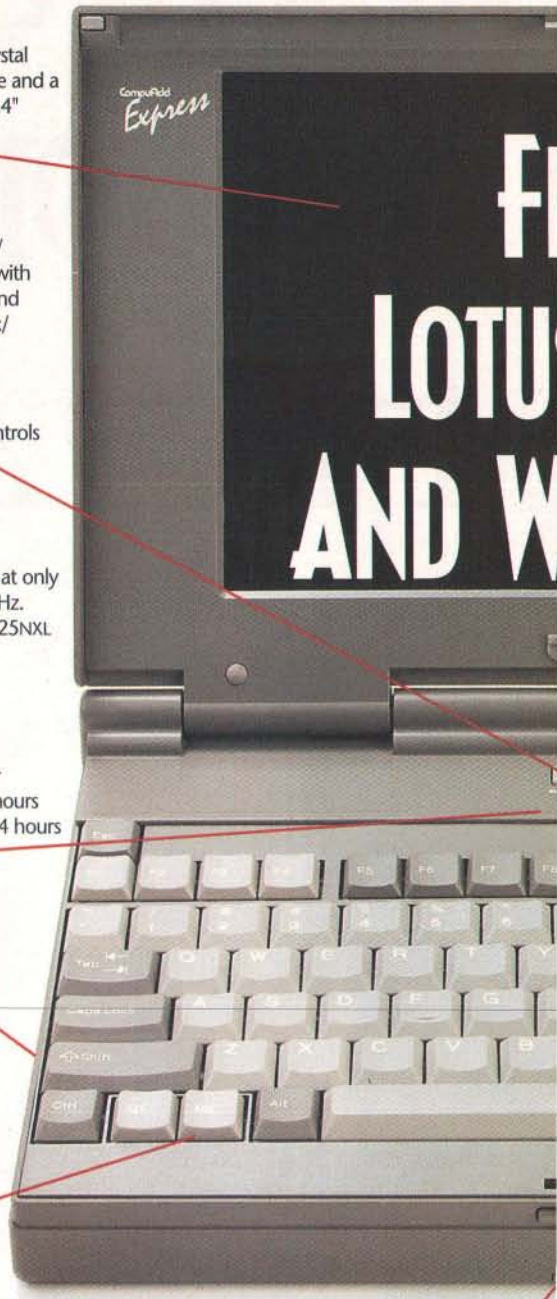

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RAM	4MB	4MB	2MB	2MB	1MB	2MB
FAX/MODEM	Yes	Option	Option	Option	Option	Option
GRAY SCALE	64	32	64	64	32	32
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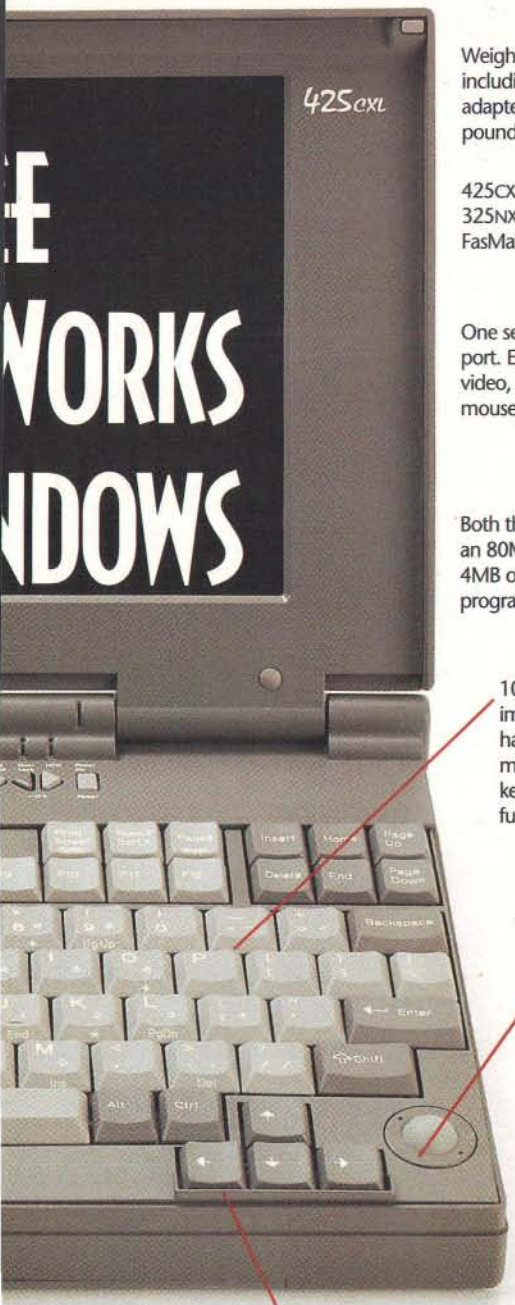

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425CXL includes a math coprocessor; 325NXL contains socket for Cyrix FasMath™ 83S87 math coprocessor

One serial port, one parallel port. External 800x600 VGA video, PS/2 keyboard and PS/2 mouse connectors.

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Express 325NXL

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Express 425CXL

The 425CXL has all the terrific features that made its 386 partner so popular. But it has extra speed, thanks to its Cyrix CX486SLC microprocessor.

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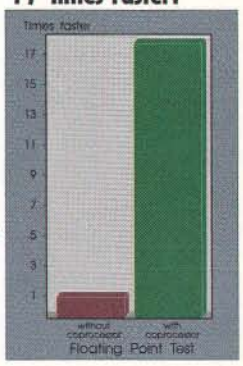
17 Times Faster!



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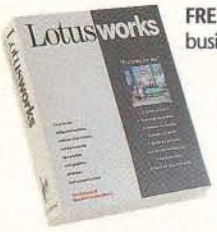

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After I added power and started running applications, though, it was obvious that the Indigo's distinctive deep-purple case no longer contained an ordinary RISC processor. The system was now working with a 64-bit processor and 1 MB of secondary general-purpose cache memory connected to the CPU. (There's also 8 KB each of instruction and data primary cache memory.)

The video hasn't changed from that in the R3000-based machine. As with the original Indigo system, all GL (Graphics Language) operations that would otherwise be handled by a dedicated graphics board are accomplished in software, and the 24-bit color is dithered for 8 bits in hardware.

The advantages of having a 64-bit processor didn't become apparent until I tackled compute-intensive work with high precision. It may seem unlikely that a tiny desktop workstation such as the Iris Indigo would run applications that take advantage of the processor depth of the R4000. Remember, though, that the Indigo comes from the leader in systems for creating and viewing 3-D image rendering and animation. A single 24-bit-color, 1280- by 1024-pixel image needs 3.75 MB; 45 seconds of video (at only 24 frames a second) requires more than 4 GB.

Although the Indigo is limited to 384 MB of RAM, the trend is to take advantage of virtual memory addressing and memory-mapped files. For the kind of applications that SGI workstations are destined to run, 32-bit processing clamps down the possibilities.

Thanks to the R4000, my integer performance moved from 47,000 Dhrystones per second (on the R3000 Indigo) to 108,000 Dhrystones per second. My double-precision floating-point performance (BYTE's Unix benchmark) increased from 13,000 loops per second to 22,000 loops per second.

Credit these performance increases to the superpipelined R4000 (it runs at 100 MHz internally while maintaining a 50-MHz appearance to the external bus) and to a floating-point processor that's internal to the single CPU chip. Even programs compiled for the R3000 processor will run noticeably faster. To take full advantage of the R4000, though, you must recompile programs specifically for it.

In spite of these impressive performance increases, some aspects of the system (in particular, spawning new processes and system loading) show little or no improvement from having the powerful R4000 64-bit processor. If your system performance demands are focused on the speed of creating and killing processes, you'll have to reconfigure your Unix kernel or step up to the Crimson.

The R4000 Indigo offers image manipulation and graphics design power to Mac users (or anyone else, for that matter) at a price/performance level beyond that of even a Quadra with graphics coprocessors. If SGI continues in this direction, the Indigo is going to be an attractive Unix alternative to the Mac.

—Ben Smith

THE FACTS

R4000 upgrade for R3000 (includes heavy-duty power supply), $6500

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R3000 base system (with 15-inch color monitor and 16 MB of RAM), $7995

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When we heard that Gateway and Hyundai both had DX2/66 VESA (Video Electronics Standards Association) local-bus systems priced at $2995, we had to take a closer look. Fortunately, both companies had preproduction systems we could try out.

On paper, the **Gateway 2000 4DX2-66V** looks like a screamer. Inside the AT-size desktop enclosure is a 33-/66-MHz 486, arguably the fastest Intel-compatible processor available—this week at least. The system is also turbocharged with an external 64-KB cache, which is expandable to 256 KB.

For additional speed, the processor is connected to one of the first implementations of a VESA VL-bus local bus with two slots. One of these local-bus slots is taken up by a new ATI Technologies local-bus video card with 1 MB of VRAM (video RAM). This card can display up to 64,000 colors and resolutions of up to 1280 by 1024 pixels. Also on the local bus is an IDE drive controller connected to a 340-MB hard drive.

Contrary to common expectations, this power *does* come cheaply—relatively speaking. The system, with a 15-inch color monitor, two floppy drives, 8 MB of memory, Windows 3.1, a mouse, and one Windows application, has a direct-from-Gateway price of $2995.

How fast is this thing? Very. Preliminary tests with BYTE benchmarks give this system very high CPU and video indexes. This may be the machine to beat in the DX2 series.

Call it a reverse of the Asian model of computing: Hyundai, in order to get closer to its U.S. customers, has moved its PC manufacturing, marketing, and development operations from South Korea to San Jose, California. Expect Hyundai Electronics America to introduce 40 desktop and notebook PCs by the end of the year.

HEA's plan is to compete head-on in the U.S. with companies such as Gateway 2000 and Dell. The preproduction **Hyundai 466D2** we previewed was a VESA VL-bus 486DX2/66 system with a Super VGA monitor, a 200-MB hard drive, 128 KB of write-back cache memory (expandable to 256 KB), 4 MB of RAM, and two floppy drives.

When running compute-intensive applications like a Windows word processor or a 3-D modeling program, the Hyundai system turned in impressive results.

HEA shipped the system with a 33-MHz chip. A few days later, the 66-MHz OverDrive upgrade arrived. Upgrading the system wasn't much of a fuss. All it involved was rotating a lever, pulling out the old chip, aligning a dot to a notch, and dropping the new processor in the socket. Even so, new users may find the procedure complicated. To take advantage of the speed upgrade, you need to verify that your jumpers are properly configured, and the jumpers are somewhat hidden under the removable hard drive, which is mounted

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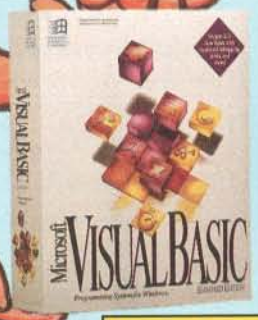

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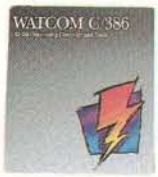

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sideways over the motherboard.

The inside of HEA's 33/66 system is roomy indeed. The system has six 16-bit slots; one VL-bus expansion slot, which was taken up by the same ATI local-bus video card found in the Gateway system; and seven (four 3½-inch, three 5¼-inch) storage bays. The advanced CMOS Setup program lets you change or enable/disable the addresses for the on-board COM and LPT ports, automatic IDE drive-type detection, and an antivirus boot block.

Perhaps the most interesting element of both the Gateway and HEA machines is their ATI VESA local-bus graphics adapters. Not only does the card improve the performance of the systems' displays of standard graphics images, it has built-in drivers to support Microsoft's Video for Windows. With the ATI card, you can play full-screen (i.e., 1024- by 768-pixel) movies in 65,000 colors at 30 frames per second.

The Gateway and Hyundai systems we previewed pack a lot of value for less than $3000. Expect other PC vendors to follow suit.

—Rich Malloy and Dave Andrews

THE FACTS

Gateway 2000 4DX2-66V
$2995

Gateway 2000
610 Gateway Dr.
P.O. Box 2000
North Sioux City, SD 57049
(800) 523-2000
(605) 232-2000
fax: (605) 232-2023
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Hyundai 466D2
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San Jose, CA 95134
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Circle 1169 on Inquiry Card.

Juxtaposing "HP" and "Low-Cost"

Hewlett-Packard's new 486N series represents what's become a familiar trend in the PC marketplace: a low-cost entry from a high-end vendor. In introducing its inexpensive desktop series, HP follows in the footsteps of Compaq, IBM, and DEC. But HP has put more on the line than these others: It's risked its cachet among engineers, who associate HP with top-shelf equipment in everything from oscilloscopes to Unix workstations. Can HP make a low-cost PC up to its own reputation?

Frankly, yes. I tested an **HP Vectra 486/33N**, the middle configuration in HP's 486N line. The Vectra 486/33N combines excellent components with high integration to deliver a very usable configuration for $2299. The design also indicates that attention has been paid to expandability, ease of maintenance, and ergonomics. For example, the system board supplies both 25- and 33-MHz clocks and has processor sockets for chip upgrades.

The system board is a model of high integration, a big contributor to reliability. The most noticeable motherboard features are the two CPU sockets (one soldered in on my 486DX model), a VLSI 486 chip set, and the on-board Super VGA. HP includes an S3 graphics accelerator wired to the CPU local bus for excellent video performance; the graphics system also supports high-resolution and high-refresh-rate monitors.

The system's *N* designation comes from the bundling of HP EtherTwist or token-ring cards in some models. HP also installs DOS and Windows, and it includes a mouse in most configurations.

What's missing? Well, expansion is limited by the 70-watt power supply, three ISA slots, and little room for disk storage, but that is justified in a network client workstation. More critical is its lack of second-level cache memory, which makes it somewhat sluggish in BYTE's benchmark tests compared to high-end systems, including HP's own 486/33u (see the table). However, the accelerated video and fast IDE drive make the system highly responsive under Windows.

But besides cutting-edge performance, there's really nothing left out. Considerations such as a snap-off case and security features make the HP Vectra 486/33N ideal for multiuser environments, where easy maintenance and plug-and-play operation are essential. It's also an appealing machine for those of us who have always wanted an HP system but couldn't get beyond the price tag. ■

—Steve Apiki

BYTE LOW-LEVEL BENCHMARK INDEXES

The lack of second-level cache memory prevents the HP Vectra 486/33N from competing with higher-end systems. The unit performs well in video testing under Windows, however. (Higher numbers are better.)

	HP Vectra 486/33N	HP Vectra 486/33u	Compaq Deskpro 433i
CPU	1.14	1.39	1.41
FPU	2.25	2.31	2.31
Disk	1.05	1.28	0.98
Video	1.57	1.49	1.63

THE FACTS

HP Vectra 486/33N
with 4 MB of RAM and a 170-MB hard drive, $2299
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Licensed Education Centers	No	No	Yes
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Desktop Multimedia

Packard Bell's 486SX/25 Multimedia Computer System includes all the components you need for animating your presentations, getting the latest TV news, and accessing complete reference tools. The system has 4 MB of RAM, a 210-MB hard drive, and dual high-density floppy drives.

Featuring an internal 630-MB CD-ROM drive, a three-speaker amplified micro stereo system, and Sound Blaster Pro II, the system has an extended VGA (1024- by 768-pixel resolution) video controller with 512 KB of memory (expandable to 1 MB). A built-in fax/data modem sends faxes at 9600 bps, receives them at 4800 bps, and sends and receives data at 2400 bps. The company's PBTV3 TV/video board and a monitor complete the package.

Price: $2999.
Contact: Packard Bell, Chatsworth, CA, (818) 886-4600; fax (818) 773-9521.
Circle 1271 on Inquiry Card.

The PBTV3 card in the 486SX/25 Multimedia Computer System lets you watch TV or pictures from a VCR, laserdisc player, or camcorder while working in your spreadsheet.

Direct Data Collection

ShopPoint, designed for networked data-collection applications, lets you gather information directly through its bar code port. The DOS unit has a built-in thin-wire Ethernet interface, so you can add it directly to a NetWare or LANtastic network.

The less than l-pound computer has a built-in backlit 2-row by 40-column LCD that shows operator-entered data and prompts; you can add graphics and full-screen capabilities through the standard CGA interface. Bar code capabilities let you collect data via a bar code wand (included), a slot reader, a laser scanner, or a CCD scanner. The unit automatically recognizes most bar code symbologies.

Price: $1500.
Contact: Burr-Brown Corp., Tucson, AZ, (602) 746-1111; fax (602) 889-1510.
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Computer in a Monitor

Powerful enough to be a LAN workstation, the PC7-325 is an all-in-one computer that looks like an ordinary terminal. Located inside a 9½-inch Super VGA color monitor, the 25-MHz 386SX saves desk space.

The unit features 1 MB of RAM (expandable to 16 MB), a 40-MB 28-ms IDE hard drive, a 1.44-MB floppy drive, and a built-in video card. Other standard features are an external floppy drive port, serial and parallel ports, two 16-bit ISA slots, and DOS 5.0.

Price: $1395.
Contact: Bi-Link Computer, Inc., Whittier, CA, (310) 692-5345; fax (310) 695-9623.
Circle 1273 on Inquiry Card.

Multifunctions from a 486

An integrated desktop system that's a combination of a 486 computer, a plain-paper fax machine, a digital copier, a scanner, a laser printer, and a modem, the Gateware 3370 is also networkable. You customize and upgrade the system by adding new software.

The 33-MHz 486 PC comes with 8 MB of RAM, a 120-MB IDE hard drive, and four AT bus slots. Features include CCITT Group 3 or Group 4 fax compatibility, 300- or 400-dpi scanner resolution, any emulation on the 6-ppm laser printer, and 9600-bps send/receive capability on the data modem. The system accepts any AT card and has connections for AppleTalk, Ethernet, and IBM coaxial and twin-axial cables.

Price: $3995.
Contact: Digital Design, Inc., Jacksonville, FL, (800) 733-0908 or (904) 737-0908; fax (904) 737-1162.
Circle 1272 on Inquiry Card.

Cost-Effective Computing

Elonex makes high-speed 486-based computing cost effective with its PC-425X modular ISA desktop system. The entry-level configuration includes 2 MB of RAM (expandable to 32 MB), a 64-KB external cache, a Microid Research BIOS, a 50-MB hard drive, a mouse, a low-radiation Super VGA color monitor, one parallel and two serial ports, DOS 5.0, and Windows 3.1. The on-board floppy drive controller supports up to two devices, and the unit provides a connector for an IDE hard drive.

The Super VGA adapter contains 512 KB of VRAM (video RAM), which supports resolutions of 640 by 480 pixels and 800 by 600 pixels with 256 colors and 1024 by 768 pixels with 16 colors. A feature bus connector allows pass-through to high-resolution graphics cards.

Price: About $1700 (£895).
Contact: Elonex plc., London, U.K., +44 81 452 4444; fax +44 81 452 6422.
Circle 1274 on Inquiry Card.

Portable Hard Drive

Available in 80- and 120-MB capacities, the 30 Series portable hard drive subsystems have a SCSI connection as well as a parallel port that allows pass-through connectivity. Each unit has a self-contained power supply with an optional built-in battery charger.

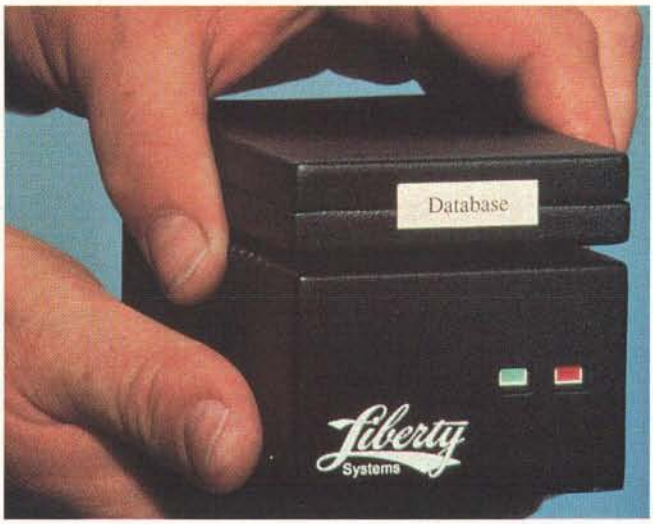
You can connect the 3- by 2½- by 5⅛-inch subsystems to PCs via the parallel port or the SCSI controller; you connect them to Macs or Next machines via a SCSI bus. With an optional backplane connector, the units are compatible with Liberty Systems' 10 Series drives, which can be piggybacked as removable media for infinite storage capacity.

Price: $899 and up; optional battery and charger, $199.
Contact: Liberty Systems, Santa Clara, CA, (408) 983-1127; fax (408) 243-2885.
Circle 1277 on Inquiry Card.

CD-ROM with Cache

The external Relax 680-MB Mesa CD-ROM drive has an access time of 650 ms and a sustained data transfer rate of 150 KBps. Compatible with PCs and Macs, the Relax Mesa's 64 KB of cache memory makes it fully compatible with the MPC and QuickTime standards. A headphone jack provides audio output capability.

Price: $299.
Contact: Relax Technology, Inc., Union City, CA, (510) 471-6112; fax (510) 471-6267.
Circle 1278 on Inquiry Card.



Liberty Systems' portable 30 Series hard drive subsystems provide cross-platform storage.

Plotters' Choice

A 24-wire dot-matrix personal printer/plotter, the Accel-244 Personal Plotter has a resolution as high as 360 by 360 dpi and scaling capabilities of from 1 to 999 percent. The unit has internal Hewlett-Packard Graphics Language 2 and AutoCAD Device Interface processors and supports A- through C-size media.

The Select-dial feature lets you choose from a variety of plot qualities and speeds, automatically scale and rotate drawings, position drawings on the page, assign line weights, save up to five plotter setups, and control an internal queue of up to 20 drawings. The print head's 8-mil wires provide smoothness and clarity while supporting all the standard line weights.

Price: $995.
Contact: Advanced Matrix Technology, Inc., Camarillo, CA, (800) 992-2264 or (805) 388-5799; fax (805) 484-5282.
Circle 1279 on Inquiry Card.

A 600- by 600-dpi-resolution ink-jet plotter, the HP DesignJet 600 has 4 MB of memory that you can upgrade to 20 MB in increments of 4 or 8 MB. With the full 20 MB, the plotter can store up to 32 plots in the queue.

Able to plot a complex E-size drawing in less than 6 minutes in final mode, the plotter has an Intel 960 processor that lets the machine rasterize and plot simultaneously. Six HP JetDirect interface cards are available for a selection of connectivity options (e.g., NetWare, LAN Manager, and Unix TCP/IP Ethernet).

Price: E size, $9995; D size, $8495.
Contact: Hewlett-Packard Co., Santa Clara, CA, (800) 752-0900; Canada (800) 387-3867; fax (208) 344-4809.
Circle 1280 on Inquiry Card.

Compact Thermal Printing

The Sejus ThermalPrinter is a self-contained, compact thermal printer designed to fit a standard 5¼-inch half-height floppy drive bay in Hewlett-Packard technical workstations. The print mechanism is housed in a drawer that slides in and out of the drive bay as needed.

An Epson-compatible nine-pin serial connector and a standard disk power connector facilitate installation. The Sejus ThermalPrinter can print in columns up to 80 characters wide in condensed type. It can print at speeds of 37 cps in standard mode and 50 cps in condensed mode. The continuous-roll paper is 38 feet long and provides about 2800 lines at 6 lines per inch.

Price: About $1611 (£895).
Contact: Workstation Source, Ltd., Berkshire, U.K., +44 628 75252; fax +44 628 75157.
Circle 1282 on Inquiry Card.

A Light Pen for Your PC

The Light Pen Port lets you add light pen compatibility to computers that do not have built-in support for light pens. Consisting of a light pen and an external interface unit about the size of a deck of cards, the Light Pen Port supports all current graphics standards and has drivers for versions 3.0 and higher of DOS and Windows. The software lets the pen and your mouse run concurrently.

Price: $350.
Contact: Design Technology, Santee, CA, (619) 448-2888; fax (619) 448-3044.
Circle 1281 on Inquiry Card.

INTRODUCING COLOR THAT GETS ALONG SWI

Now the software you always work with can produce the color you've always dreamed of.

That's because the Canon CJ10 Color Bubble-Jet™ Copier is compatible with virtually all the Macintosh® and Windows® software* from leading manufacturers, such as Aldus,® Lotus,® Adobe,™ Microsoft,® WordPerfect,® Micrografx,® you name it.

But it's not just software compatibility that makes the CJ10 so extraordinary. It's color. The same vivid color and crisp, clear, black text that made our Color Laser Copiers the industry standard.

Whether you need to scan, print or simply produce photographic-quality, full-color copies, the CJ10 brings the power and vitality of color to your favorite desktop applications at a surprisingly affordable price.

For even more versatility, Canon has developed Windows and QuickDraw® printing and scanning drivers for the CJ10. And with third party software products, the CJ10 becomes a PostScript™ language

*Requires IPU SS and CJ10 IPU Kit.

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HALO Desktop Imager

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compatible printer. So no matter what you want to create — documents, presentations, newsletters, transparencies and more, you have all the tools you need right at your fingertips.

Superior color, wide-ranging software compatibility and a very affordable price. It's an unbeatable — and unprecedented — combination that can turn your desktop into a powerful business resource.

The Canon CJ10 Color Bubble-Jet Copier. It's a wise investment for your brightest ideas.

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Circle 187 on Inquiry Card.

Windows at Warp Speed

The low-cost Volante Warp 10 Windows graphics accelerator card not only displays 24-bit true color at 640- by 480-pixel resolution, it also makes Windows operation 50 times faster through use of the S3 86C801 graphics chip and up to 1 MB of DRAM. Operating at refresh rates of from 60 to 72 Hz, the ISA-bus card also offers resolutions of 800 by 600 pixels in 65,536 colors and 1024 by 768 pixels in 256 colors. The card also can display 16 colors at 1280- by 1024-pixel resolution in interlaced mode and 16 colors at 1152- by 900-pixel resolution in non-interlaced mode.

The Volante Warp 10 ships with drivers for several applications, including AutoCAD and Lotus 1-2-3. National Design also includes its proprietary Fast Forward driver for further optimizing Windows operations. The board also features an adapter for multimedia.

Price: $299.

Contact: National Design, Inc., Austin, TX, (512) 329-5055; fax (512) 329-6326.

Circle 1283 on Inquiry Card.

Fly through your graphics in Windows with National Design's Volante Warp 10 graphics accelerator.

Turn VGA into Video

The 1000V series of VGA-to-video adapters use the Tseng 4000 VGA chip. Available in 512-KB, 1-MB, and high-color versions, the adapters include S-video, composite, and RGB video output formats in NTSC and PAL versions.

Price: $395.

Contact: Adda Technologies, Inc., Richmond, BC, Canada, (604) 278-3224; fax (604) 278-2909.

Circle 1287 on Inquiry Card.

A Board for Viewing TV

WatchItTV lets you view TV while working in your computer application. You can position the TV window anywhere on the screen and size it to ¼ or ⅙ of the viewing area; or you can have it take up the entire screen. You can freeze a TV image for transfer into other PC applications and use the pop-up control pad to change channels; adjust volume, color, and screen size; and save still images. A programmable timer turns on the TV at the time and channel you select.

Price: $349.

Contact: New Media Graphics, Billerica, MA, (508) 663-0666; fax (508) 663-6678.

Circle 1284 on Inquiry Card.

Multimedia on Your AT

Arcom Control Systems' PCVideo multimedia board lets you combine color video and VGA signals into a single display. You use software to select camera, VCR, or TV video source (in PAL, NTSC, or SECAM format) from the board's three inputs. You can display, scale, and position video windows in the VGA graphics/text display by color-keying to the VGA signal or by defining *x*, *y* coordinates. The PCVideo board lets you display one live video window plus an unlimited number of captured or frame-grabbed still images.

Price: About $1332 (£740).

Contact: Arcom Control Systems, Ltd., Cambridge, U.K., +44 223 411200; fax +44 223 410457.

Circle 1288 on Inquiry Card.

Get Dolby Sound from Your PC

A digital audio board with Dolby AC-2 coding, the Antex SX-20 provides real-time professional broadcast-quality stereo sound on your PC or PS/2. The board is based on Texas Instruments' advanced floating-point TMS320C31 DSP (digital signal processor) chip.

The Antex SX-20 provides direct-to-disk storing or transmitting of audio at 20 Hz to 20 kHz frequency response at 128 Kbps, letting you add CD-quality digital sound to your applications and transmit the sound over T-1 phone lines. The full-size board plugs directly into a single expansion slot and features software-selectable storage formats. Languages supported by the board include C, Pascal, QuickBasic, and assembly. Software drivers for Windows 3.1 are included.

Price: $2195.

Contact: Antex Electronics Corp., Gardena, CA, (310) 532-3092; fax (310) 532-8509.

Circle 1285 on Inquiry Card.

Hard Drives on a Card

Hardcard EZ hard drives on a card are guaranteed to be compatible with all AT-class computers; all popular operating systems, including DOS, OS/2, and Windows; and all conventional installed hard drives. The Hardcard EZ drives fit in a 16-bit ISA slot and have 42, 85, 127, or 240 MB of storage capacity.

Typical seek time on the drives ranges from 16 to 19 ms, and sustained data transfer rates are 1.3 or 1.4 MBps. A patented Airlock feature automatically retracts the read/write heads if the power supply is interrupted; Defect Free Interface technology identifies and marks bad sectors, eliminating data loss.

Price: $269 to $749.

Contact: Quantum Corp., Milpitas, CA, (408) 432-1100; fax (408) 434-0420.

Circle 1286 on Inquiry Card.

PICTURE WINDOWS.

Picture This... a real-time television monitor built right into your P.C... Now, picture using this monitor while running Windows™ 3 applications **at the same time...** And, picture taking that video image and resizing, **(right down to crystal-clear icon size!)** or clicking and dragging it to any position on the screen as easily as moving any other Window...

Now you can! Any Windows 3 user can access 122 channel television reception with the built-in tuner, PLUS two additional video sources, (such as VCR, video camera, laser disk, etc.,) all with stereo audio capability! Automatically fit real-time video images into any size Window while running your other Windows 3 programs. *Hauppauge Computer Works* introduces **Win/TV™**, the Windows television adapter.

Picture Perfect. A "frame-grabber" feature allows you to capture any desired "still" from a video source and save it to disk. With **Win/TV**, you can integrate video images into multi-media applications such as training or marketing presentations. All you need is Windows 3, a VGA monitor, and a system with a spare 16-bit I/O slot, and you are ready to view a whole new world of video creativity!

Picture Yourself owning your own "Windows on the World"! Maybe you want to work on your spreadsheets but don't want to miss an important news flash or a current stock market report. **Win/TV** is *perfect* for you. Keep an eye on current events while keeping control of your inventory... No problem!

Get the new **Win/TV** and open a window on some fresh, new and exciting possibilities.

Available Internationally from:

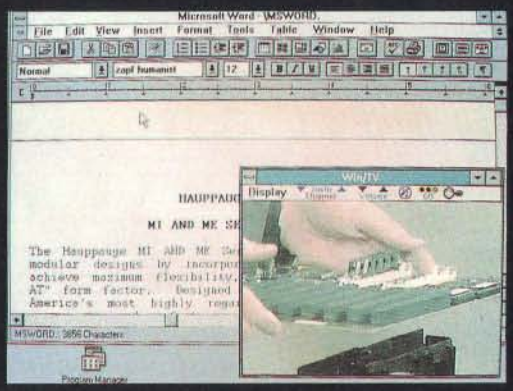
Western Computer, Australia	*07-262-3122*	*E.I.E., Japan*	*03-3572-3442*
Hauppauge, Germany	*02161-17063*	*Hauppauge, U.K.*	*071-378-7309*

GSA# GS00K92AGS6156

Circle 101 on Inquiry Card

SUGGESTED RETAIL **$495.**

***You're never out of touch with your own personal* "Windows on the World"!**



Resize or reposition your* Win/TV *Window anywhere on the screen—while running other Windows applications.

***Capture the perfect "still" with "Frame Grabber" feature—great for presentations with* impact.**

Hauppauge!

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91 Cabot Court • Hauppauge, N.Y. 11788
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For years, the Amiga® name has been synonymous with multimedia. We've proven to the world that when you combine the brilliance of video, audio, and animation with a computer, incredible things can happen.

Well, now that the world has finally caught on to the concept, Commodore takes the medium to an entirely new level: With the all-new Amiga 4000.

The A4000 frees you to do more multimedia computing for less than any other personal computer. It empowers you to create exciting professional television effects, stimulating interactive training programs, and more powerful presentations like never before.*

That's because the Amiga is the only computer designed as a multimedia machine from the ground up. Which means the A4000 doesn't suffer the handicaps other so-called multimedia machines endure. There is no need for costly, cumbersome add-ons, no need to kludge together potentially incompatible components. So it gives you spectacular multimedia performance right out of the box, at a price that keeps the cost of imagination very realistic.

Sit in front of the A4000 and instantly you enter a world filled with high-resolution graphics simultaneously displayed in up to 256,000 colors from a palette of over 16.8 million hues. You gain a heightened ability to create exciting graphics with full video overscan. And you attain the freedom to create complex animations at a full 30 Frames Per Second, not at 15 FPS.

The Amiga 4000 features the power new Motorola® 680 microprocessor.

You even have the option of choosing from a spectrum of high resolution modes while still maintaining NTSC scan rate capability.

All this multimedia muscle, of course, comes through true design elegance. At the heart of every A4000 lies our new, unique, custom coprocessors, the Advanced

The Amiga 4000 gives you the ability to easily create real-time, colorful animations.

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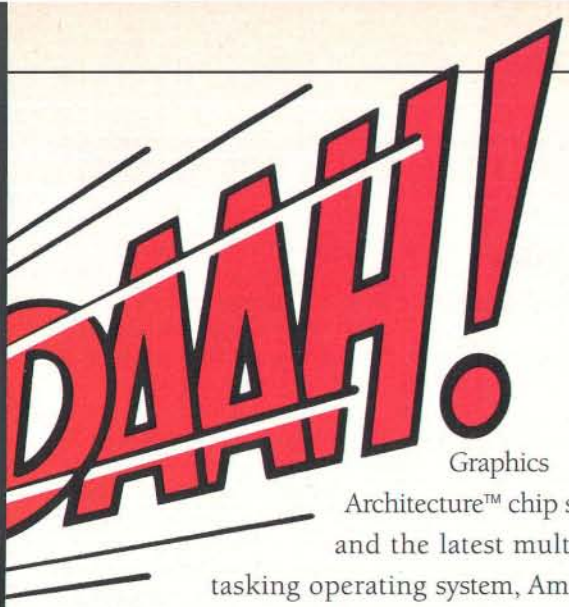
U.S. through an authorized Commodore-Amiga dealer. Customer activation required. Some optional programs require a charge. MS-DOS is a registered trade



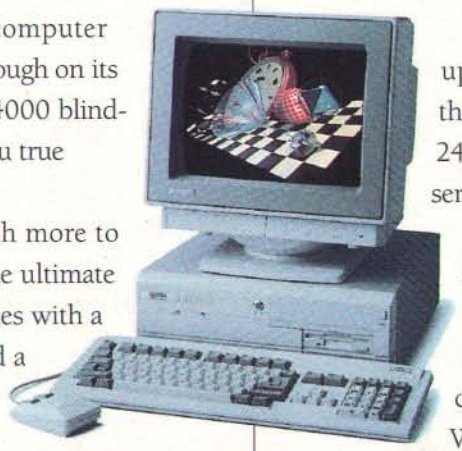
Graphics Architecture™ chip set, and the latest multitasking operating system, Amiga DOS™ 3.0. Add to this Motorola's thundering 68040 Chip (which other computer companies consider to be enough on its own), and not only is the A4000 blindingly quick, it literally gives you true workstation power.

Of course, there's much more to the A4000 than just being the ultimate tool for creativity. It also comes with a large capacity hard drive, and a 1.76 MB dual speed high density floppy drive which, combined with Cross-DOS, allows you to read and write MS-DOS® files. And a design that allows for expandability, compatibility, and the capability for hundreds of business applications.

In fact, the A4000 even fits seamlessly into whatever operating system you're currently using by coexisting and communicating with your Macintosh® or MS-DOS computers in a Novell® network.*

With a dedicated chip for audio, the A 4000 sounds like nothing you've ever heard.

Announcing The Amiga® 4000. The Encore To The Most Powerful, Cost Effective Multimedia Computers Ever.



And we back all this technology up with a potent service package that is second to none: Including a 24 hour hotline and optional on-site service.**

To find out more about Commodore Multimedia and the all-new Amiga 4000, call 1-800-66-AMIGA. (In Canada, call 1-800-661-AMIGA.) We'll show you an outstanding performance that will certainly bring you to your feet.

Commodore® AMIGA®

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Circle 79 on Inquiry Card.

Three-in-One Communication

A telecommunications system manager from SIIG, The Telecommunicator combines voice-mail, fax, and modem capabilities into one card for the IBM AT. The card operates in the background, so you can use other Windows-based applications while it administers all phone line–based communication, automatically switching between voice communications and receiving faxes.

The voice-mail system provides a phone book, remote operation, message forwarding, password protection, and 999 voice mailboxes. The Telecommunicator's Group 3 fax capability includes a Fax Scheduler, a Fax Server, the ability to merge text and graphics on a single fax, and the ability to send faxes as text files in PCX, TIF, IMG, or BFX formats.

The card's Hayes-compatible modem features include MNP 5 data compression and V.42 error correction. You can use The Telecommunicator with most popular communications software packages.

Price: $349.
Contact: SIIG, Inc., Fremont, CA, (510) 657-8688; fax (510) 657-5962.
Circle 1330 on Inquiry Card.

PCL/PostScript Printing

Extended Systems' BridgePort ESI-2679C allows a single PostScript printer to support multiple computing platforms. The device can switch between PCL and PostScript languages on a variety of Lexmark, Apple, and Hewlett-Packard printers, automatically configuring the printer to the appropriate language.

The BridgePort connects to PCs, workstations, and Macs through its Centronics, ExtendedLink, and AppleTalk ports. It connects to the PostScript printer via serial, parallel, or LocalTalk ports.

Price: $595.
Contact: Extended Systems, Boise, ID, (800) 235-7576 or (406) 587-7575.
Circle 1331 on Inquiry Card.

Log-in Security

Nok Nok Pro, a security, accounting, and performance tool for use on AppleShare 3.0 servers, provides a detailed log of connections, the capability to disconnect idle users, and identification of guest users. The software also alerts the network administrator to log-ins as they occur.

As a security measure, Nok Nok Pro watches as guests log onto the servers and determines who they are; it then alerts the administrator or creates an entry in the log. Nok Nok Pro keeps the log in an easily exportable format, which lets the administrator track departmental and individual usage statistics. The software also lets the administrator determine peak usage times and set disconnect times based on total connect or idle time.

Price: $295 per server.
Contact: Trik, Inc., Woburn, MA, (800) 466-8745 or (617) 933-8810; fax (617) 933-8648.
Circle 1291 on Inquiry Card.

Secure Your Network Power

LanSafe II, an integrated power management system, lets network administrators centrally manage electrical power to local and remote network components. The system lets you troubleshoot power problems and monitor real-time loads and battery and voltage status. In the event of a prolonged power outage, LanSafe II begins an orderly shutdown of the network.

The system has automatic daily hardware and battery self-testing and software-controlled preventive maintenance procedures. Pull-down menus let you change power and program settings, conduct networkwide tests, reboot or shut down nodes, and view a historical log of power events. The PowerPro feature lets you set upper and lower voltage limits to optimize the brownout voltage range of your system.

Price: $135; upgrade from LanSafe/A.I.+, $69.
Contact: Network Security Systems, Inc., San Diego, CA, (800) 755-7078 or (619) 587-7950; fax (619) 552-9162.
Circle 1290 on Inquiry Card.

Two Tiny Modems

About the size of an electric razor, the Transportable 14.4/14.4 fax/data modem sends and receives faxes and data at 14,400 bps and has optional OCR (optical character recognition) capabilities. Designed for duty on your desk and on the road, the modem operates in DOS and Windows and on the Mac via the serial port. The Solectek modem is compatible with the Hayes data communications standard and Group 3 Class 1 and 2 fax standards. It supports MNP 2 through 4, MNP 5, V.42, and V.42bis. Features include group broadcasting, call logging, and background operation. When using V.42bis, the unit has an effective speed of up to 57,600 bps.

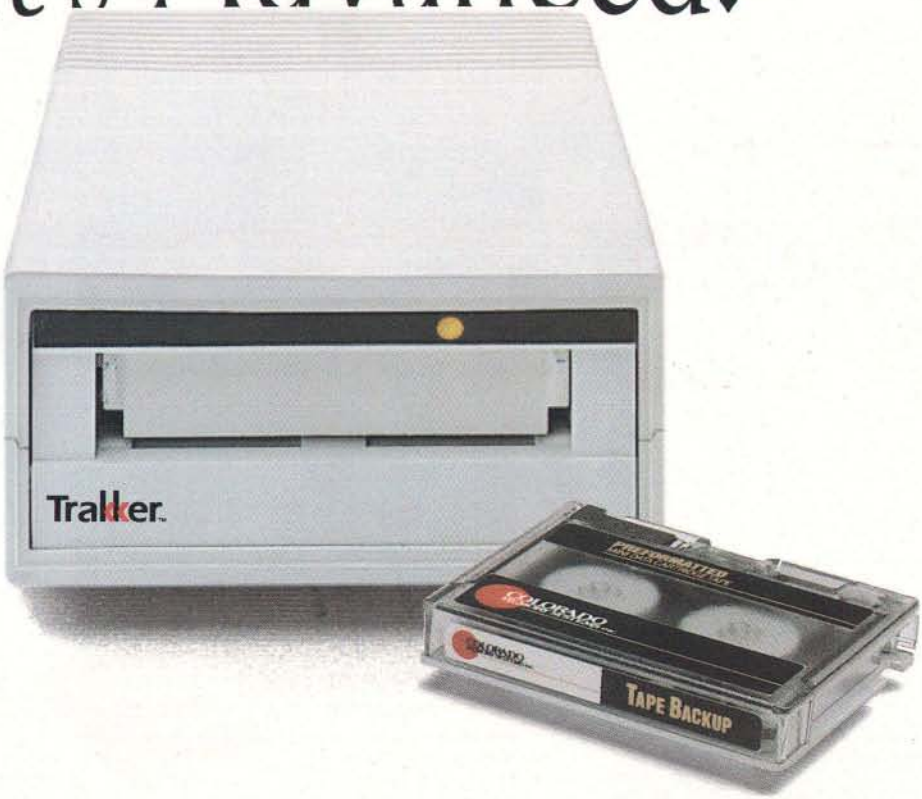
Price: $599.
Contact: Solectek Corp., San Diego, CA, (619) 450-1220; fax (619) 457-2681.
Circle 1292 on Inquiry Card.

The fist-size ALM 3226 fax/cellular data modem for laptops and PCs plugs directly into your computer's serial port without using a cable. Able to handle computer data at speeds of 75 to 14,400 bps, the modem supports V.42 error correction and V.42bis data compression for speeds of up to 57,600 bps.

Racal-Datacom's Modem Manager feature lets you configure, diagnose, and control the modem remotely and provides call-back capability. The modem, compatible with the Hayes AT command set and with Group 3 Class 1 and 2 fax data transmission, can send data over cellular or standard phone lines. It provides MNP 10 error correction for cellular data transmission.

Price: $750.
Contact: Racal-Datacom, Inc., Sunrise, FL, (305) 846-1601; fax (305) 846-3935.
Circle 1293 on Inquiry Card.

Backup so Simple, It's Advanced.



Introducing Jumbo Trakker™ Printer Port Tape Backup.

Now, backing up your computer is easier than ever. Simply unpack Trakker and connect it to your computer's parallel printer port. That's it. No installation, no switches, no floppy disk shuffle. This is tape backup that's ready to go. And it *goes* anywhere. Trakker is light and compact, the ideal solution for backing up notebooks and laptops. And it *goes* fast. Trakker 250 boasts a data transfer rate of up to 8 MB/minute, *easily* the fastest in its class. At $448, Trakker 120 is the price leader as well.

Choose either Trakker 120 (120 MB with data compression) or Trakker 250 (250 MB with data compression). Both offer QIC Industry Standard Recording Format, as well as Novell® and LANtastic® certification.

For more information, please call **1-800-451-0897** ext. 1657 today.

Trakker™

Printer Port Tape Backup

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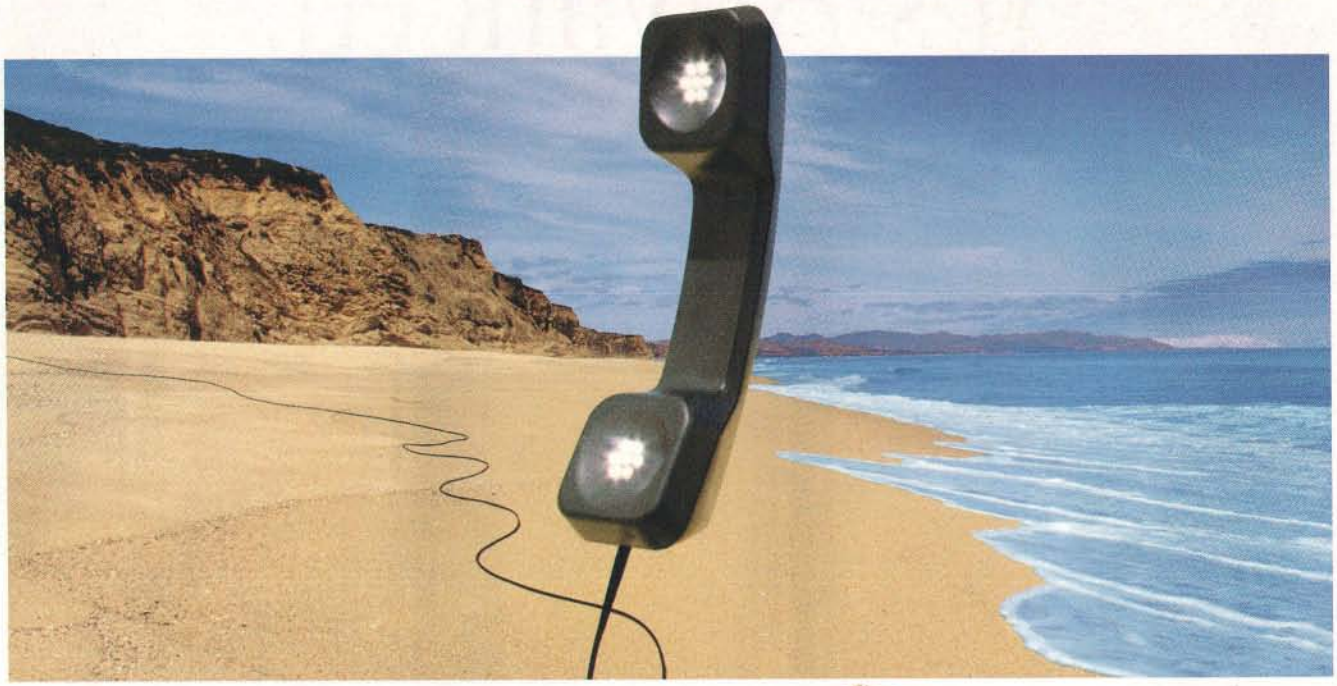
Your Natural Resource



Keyboards

- 8088/286/386/486 compatible
- Automatically switch between XT or AT
- One-year warranty

Part No.	Product No.	Description	Price
DB17128	FKB4700	Fujitsu 101-key enhanced keyboard	$79.95
DB17136	FK5001	130-key enhanced keyboard with calculator	99.95
DB20474	JE2018	32-key serial keypad	59.95
DB67432	K101	101-key enhanced keyboard (90-day warranty)	49.95
DB20431	JE2015	84-key keyboard (original AT style layout; 90-day warranty)	49.95

Power Supplies

DB19465

- One-year warranty

Part No.	Product No.	Description	Price
DB19465	JE1030	150 watt 8088	$69.95
DB67467	JE1030A	200 watt 8088	89.95
DB19545	JE1036	200 watt 286/386/486	89.95
DB19570	JE1038A	250 watt 286/386/486	99.95
DB65728	JE1039A	300 watt 286/386/486	149.95

KaLok Hard Disk Drive

- 90-day warranty

Part No.	Product No.	Description	Price
DB22322	KL320	20MB MFM hard drive	$169.95

Call for information on controller cards.

Hard Drives (IDE)

Conner IDE

- 8088/286/386/486 compatible
- Requires host IDE adapter
- One-year warranty

Part No.	Product No.	Capacity	Speed	Price
DB14058	CP3000	40MB	25ms	$249.95
DB14066	CP30084	80MB	25ms	359.95
DB14074	CP30104	120MB	19ms	429.95
DB14120	CP3204	200MB	16ms	699.95

Controllers

IDE Disk Drive Adapter Cards

DB10268

- Interfaces two IDE hard drives to system
- One-year warranty

Part No.	Product No.	Description	Price
DB10233	ADP20	16-bit hard adapter	$29.95
DB10250	ADP20F	16-bit hard/floppy adapter	39.95
DB10268	ADP50	8-bit hard adapter	79.95
DB10276	ADP60	16-bit hard adapter with BIOS	79.95
DB10284	ADP60F	16-bit hard/floppy adapter with BIOS	99.95
DB74114	ADP65F	Quad floppy controller/IDE	129.95

TEAC Combination Disk Drive

- IBM PC/XT/AT and compatibles
- 3.5" and 5.25" disk drives in a 5.25" half height drive bay

3.5" Disk Formats

- 1.44MB • 720KB

5.25" Disk Formats

- 1.2MB • 360KB • One-year warranty

Part No.	Price
DB74392	$229.95

TEAC 3.5" 2.88MB Disk Drive

- IBM PC/XT/AT and compatibles
- One-year warranty
- 2.88MB/1.44MB/720KB compatible

Part No.	Price
DB74384	$149.95

Jameco Power Base

- Master power switch and 5 auxillary switches for each outlet
- 15A, 125 VAC, 1875 watts, 60Hz
- Maximum spike: 80 joules one time
- Maximum spike volts: 6,000V
- Clamping response time: 10ns
- Color: beige

Part No.	Product No.	Price
DB20159	JE1190	$29.95

Six-Outlet Power Strip

- Built-in safety circuit breaker (15 amps)
- Master switch with pilot light
- Three-prong, 6-foot power cord
- UL listed

Part No.	Product No.	Price
DB20175	JE1191	$11.95

Floppy Disk Drives

Toshiba 1.44MB 3.5" Internal Floppy Disk Drive

DB40774

- 8088/286/386/486 compatible*
- One-year warranty

Part No.	Product No.	Price
DB40774	356KU	$99.95

*Requires JE1043 or JE1049 floppy controllers for 8088 machines.

Additional Internal Floppy Disk Drives

- One-year warranty

Part No.	Product No	Description	Price
DB17099	FD55B	5.25" TEAC 360KB	$89.95
DB17101	FD55G	5.25" TEAC 1.2MB	99.95

Floppy Controllers

- One-year warranty

Part No.	Product No.	Description	Price
DB19617	JE1043	88/286/386/486 two-drive	$49.95
DB19668	JE1049	88/286/386/486 four-drive	59.95

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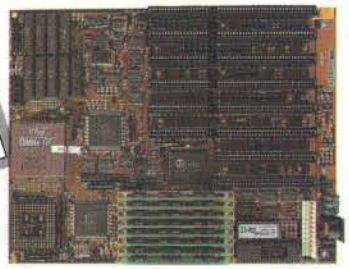
80386/80486 Motherboards



DB75643

- One-year warranty

Part No.	Description	RAM	Price
DB75619	80386DX 33Mhz	2MB	$489.95
DB75627	80386DX 40Mhz	4MB	585.95
DB75635	80486DX 33Mhz	8MB	1,009.95
DB75643	80486DX 50Mhz	8MB	1,639.95
DB75651	80486DX 50Mhz	16MB	2,749.95

Additional Jameco Motherboards

- One-year warranty
- RAM not included

Part No.	Product No.	Description	Price
DB53882	JE3616SN	80386SX 16MHz motherboard	$209.95
DB20941	JE3006	80286 12MHz motherboard	124.95
DB67521	JE1002BE	8088 10MHz motherboard	69.95

(JE1002BE comes with Wordstar word processing software)

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Expand your memory. See our excellent selection at low prices for all types of RAM. Jameco also offers memory modules for Apple, AST, Compaq, Epson, IBM, Hewlett-Packard and Toshiba computers.

DIP

Part No.	Product No.	Pins	Function		Price
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DB41427	41256-150	16	256K	150ns	1.59
DB42251	511000P-80	18	1MB	80ns	5.99
DB42219	511000P-10	18	1MB	100ns	5.49

SIPPs and SIMMs

DB41451	41256A9A-10	256K SIPP	100ns	$18.95
DB41523	41256A9B-80	256K SIMM	80ns	16.95
DB41718	421000A9A-80	1MB SIPP	80ns	54.95

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Computer Cards

16-bit VGA Card

- 8088/286/386/486 compatible
- Comes with 256KB video RAM expandable to 512KB
- Capable of 640 x 480 with 256 colors, 800 x 600 with 256 colors, 1024 x 768 with 16 colors (512KB RAM required for all modes)
- One-year warranty

Part No.	Product No.	Price
DB67459	VG7700	$99.95

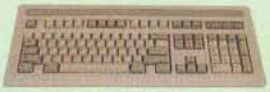
Additional Cards

Part No.	Product No.	Function	Price
DB19596	JE1040	8088 floppy controller	$19.95
DB19705	JE1050A	8088/286/386/486 monochrome graphics adapter	49.95
DB19781	JE1058S	8088/286/386/486 Super VGA	159.95
DB19801	JE1060	8088 I/O	59.95
DB19828	JE1062	8088/286/386/486 RS232 serial (16450 UART)	29.95
DB67053	JE1062A	8088/286/386/486 RS232 serial (16550 UART)	39.95
DB19844	JE1065	80286/386/486 I/O	49.95
DB19895	JE1075	8088 multi I/O w/floppy controller	69.95
DB19908	JE1076	80286/386/486 multi I/O w/floppy controller	69.95
DB19975	JE1080	8088 memory expansion half card	49.95
DB29313	RAMQUEST	8088/286/386/486 Orchid 32MB memory card	154.95

Cables, Gender Changers, and Adapters

Part No.	Product No.	Description	Price
DB28716	PPC6	6-foot parallel DB25-pin male to Centronics male printer cable	$7.95
DB28708	PPC12	12-foot parallel DB25-pin male to Centronics male printer cable	10.95
DB31721	SAT6	6-foot 9-pin serial DE9 female to DB25 male cable	5.95
DB39511	25M10F	10-foot DB25-pin male to female cable extension	9.95
DB39538	25M10M	10-foot DB25-pin male to male cable extension	9.95
DB18420	GC25F	DB25-pin female slim line gender changer	4.49
DB18446	GC25M	DB25-pin male slim line gender changer	4.49
DB10305	AD925	DE9 female to DB25 male serial adapter	4.95
DB10321	AD926	DE9 male to DB25 female serial adapter	4.95

HOLIDAY SPECIALS



101-Key Enhanced Keyboard

- IBM PC/XT/AT/386/486 compatible
- LED indicators for Num lock, Caps lock and Scroll lock keys
- 12 function keys with separate cursor and numeric keys

Part No.	Product No.	Description	Price
DB67432	K101	Keyboard	$49.95

12" VGA Monochrome Paper White Monitor

- IBM PC/XT/AT & compatibles
- Supports video modes up to 640 x 480 with 16 shades of gray
- 15 pin analog connector
- Size: 14.5"L x 12"W x 11"H

Part No.	Product No.	Description	Price
DB67491	MVGA	Monitor	$89.95

Additional monitors and keyboards available!

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Manage Change Requests

Hewlett-Packard's ChangeVision, a software change-request management environment for its SoftBench tool-integration platform for Unix PCs, helps development teams change new or existing software to eliminate defects, add new features, or port the software to different computer systems. Once the team defines a process, ChangeVision provides real-time communication and status reports that link the process with the people who perform the tasks and the software they use.

ChangeVision collects, analyzes, and correlates software measurements such as code complexity, defect density, test coverage, and schedule status. The system collects these measurements automatically and provides software teams with insight into the status of their projects.
Price: $2950.
Contact: Hewlett-Packard Co., Santa Clara, CA, (800) 637-7740 or (303) 229-4527; fax (303) 229-2180.
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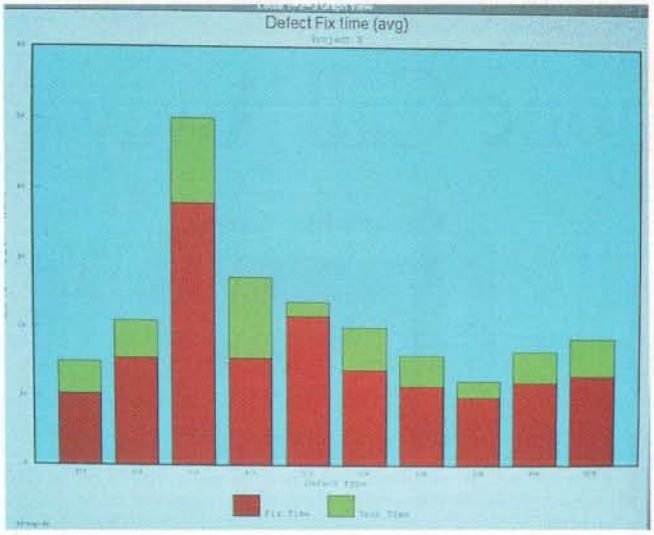

ChangeVision helps software developers define, automate, and measure the processes they use to change software.

The Programmer's Speech Toolkit

With ProVoice, you can add synthesized speech to your DOS applications. The package uses First Byte Software's Speech Engine, which processes strings of text, numbers, and data into words and sentences using a dictionary and English grammar rules. You can edit the dictionary to include words that ProVoice doesn't recognize or mispronounces.

The toolkit provides source code bindings to the ProVoice Speech Engine for Microsoft C, Turbo C++, Turbo Pascal, Turbo Assembler, and Microsoft Assembler. The bindings allow applications to make calls to a TSR speech engine, which translates the text into speech.
Price: $595.
Contact: First Byte Software, Torrance, CA, (800) 523-2983 or (310) 793-0600; fax (310) 793-0601.
Circle 1295 on Inquiry Card.

Five DLLs for Windows

The Out of Controls package from Celect Software provides five DLLs that developers can use in software running under Windows 3.0 or higher. The DLLs—Spin Box, Multicolumn List Box, Modal Spawning Library, Text Editor, and Line Object Editor—enhance the functionality and appearance of Windows applications while saving programming and debugging time.
Price: $229; with C source code, $459.
Contact: Celect Software, Mason, OH, (513) 573-6800; fax (513) 573-6888.
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Real-Time Kernel

Written to support a virtual single-processor model, the RTXC/MP package is a fully distributed real-time kernel that bridges the gap between single and parallel processing systems. With RTXC/MP, the step to multiprocessor applications involves minor changes to the system-definition file, the automatic regeneration of the include files, and recompilation of the application.

The RTXC/MP package is for DOS, OS/2, Unix, and OS/9 host environments and comes in four versions (i.e., basic and full library, single-processor and multiprocessor support) with the same API for all target processors. The package includes a standard I/O and graphics library, a task-level debugger, and a tracing monitor.
Price: $900 to $12,900, including source code.
Contact: Intelligent Systems International N.V./S.A., Linden, Belgium, +32 16 62 15 85; fax +32 16 62 15 84.
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Faster Unix Development

Using an intuitive user interface based on a point-and-click structure, C/Spot/Run combines semantic analysis, syntax checking, dependency analysis, source code filtering and navigation, graphical representation of function calls, and error filtering and navigation. The programming tool for Unix helps you spot errors, understand dependency relationships, and evaluate code structure to achieve running code faster. You can filter code to focus on lines of interest and expand context around those areas. The software identifies potential compiler and linker errors for host and remote environments.
Price: $995.
Contact: ProCase Corp., Santa Clara, CA, (408) 727-0714; fax (408) 492-1814.
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Create Demos and Tutorials

Genus Microprogramming has added more than 35 video and animation effects, Music Definition Language support, Sound Blaster voice file support, extended memory support, and control sets with variables and tests to the new version of Proteus, its prototype/demo tool for the PC. Proteus 6.0 helps you easily create demos, tutorials, and software prototypes that combine text on graphics with advanced effects and custom sounds and music. The package also lets you group demo files into a single .EXE file and set the demo to expire after a specified date.
Price: $349.
Contact: Genus Microprogramming, Houston, TX, (800) 227-0918 or (713) 870-0737; fax (713) 870-0288.
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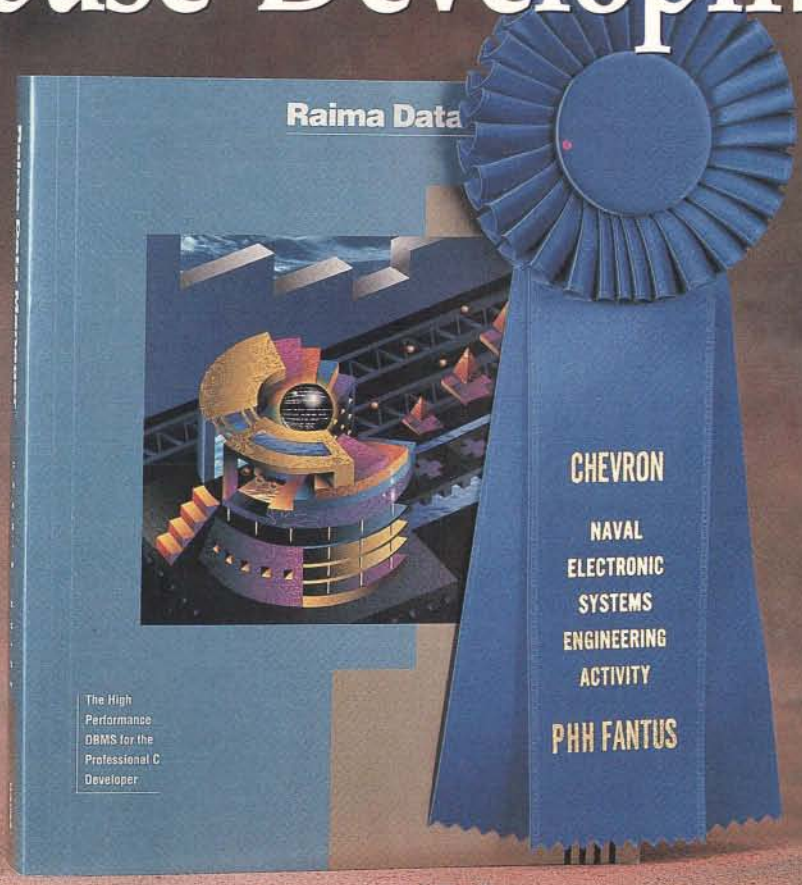
Since when is Raima first in Corporate Database Development?



Since April 7, 1992

Raima Database Manager was the database of choice in the First Annual Windows World Open. The competition featured innovative custom applications built with Windows development tools. Three of the seven winners, and two of the finalists, used *Raima Database Manager* to solve their critical application needs.

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Dave Cooper, developer, Atlantic Research Corp,
(subcontractor, Naval Electronic Systems Engineering Activity)

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Kelly Patrick, developer, PHH Fantus

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Raima Object Manager *The object storage class library*

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PC-433: 33MHz 486DX, 64k cache (max 1MB)

PC-425X: 25MHz 486SX, 64 cache (max 1 MB)

PC-420X: 20MHz 486SX, 8k internal cache

WAC 92 Windows Accelerator Card
S3-based windows accelerator, VGA compatible, up to 1280 x 1024 pixels, 1MB Video Ram, 256 from a palette of 262,000 colours

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1280 x 1024 pixels, interlaced and non-interlaced, XV17: 17", XV20: 20" Trinitron.

Sample Colour Price

NEW POWER OPTION
PC-466M

4MB RAM, 66MHz, 486 DX2

£1595

512k Video RAM	Colour VGA		S3 VGA Windows Accelerator	
Monitor	SVGA	XV17	XV17	XV20
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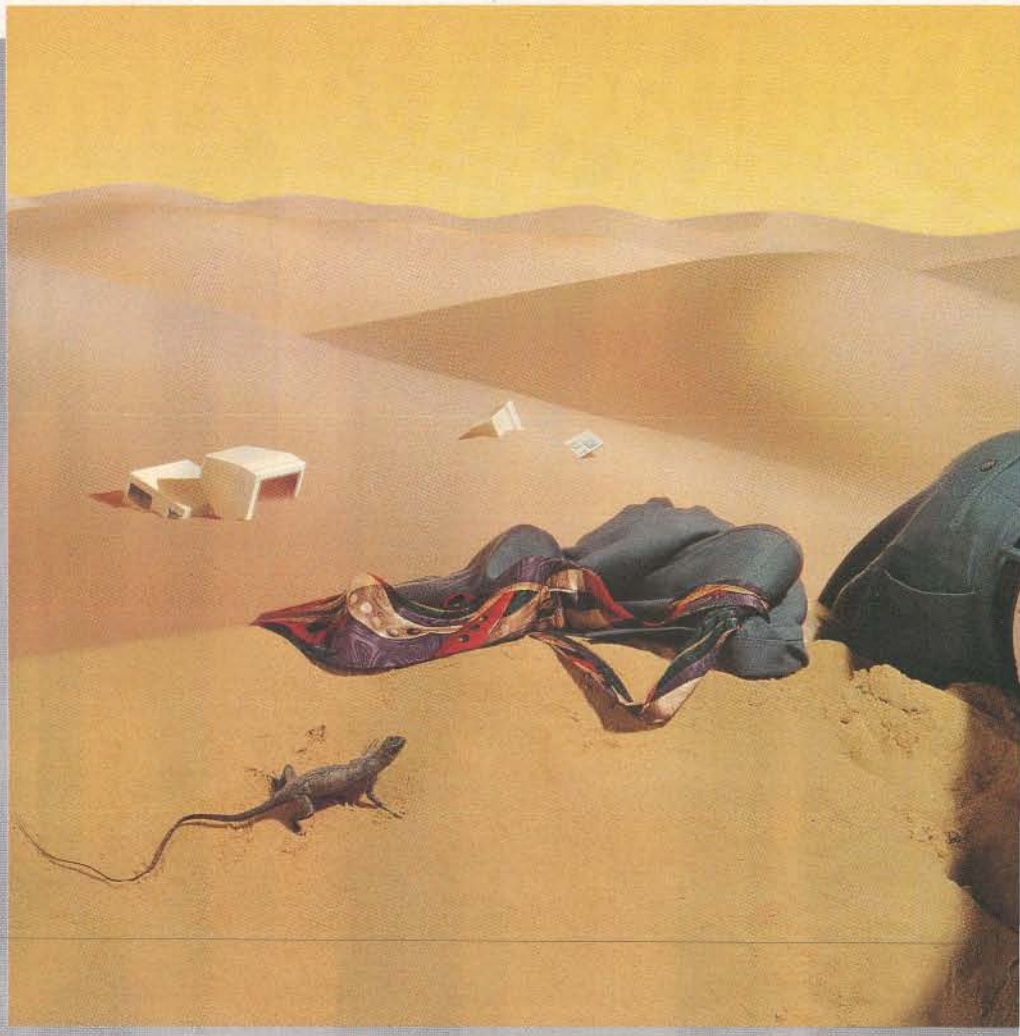

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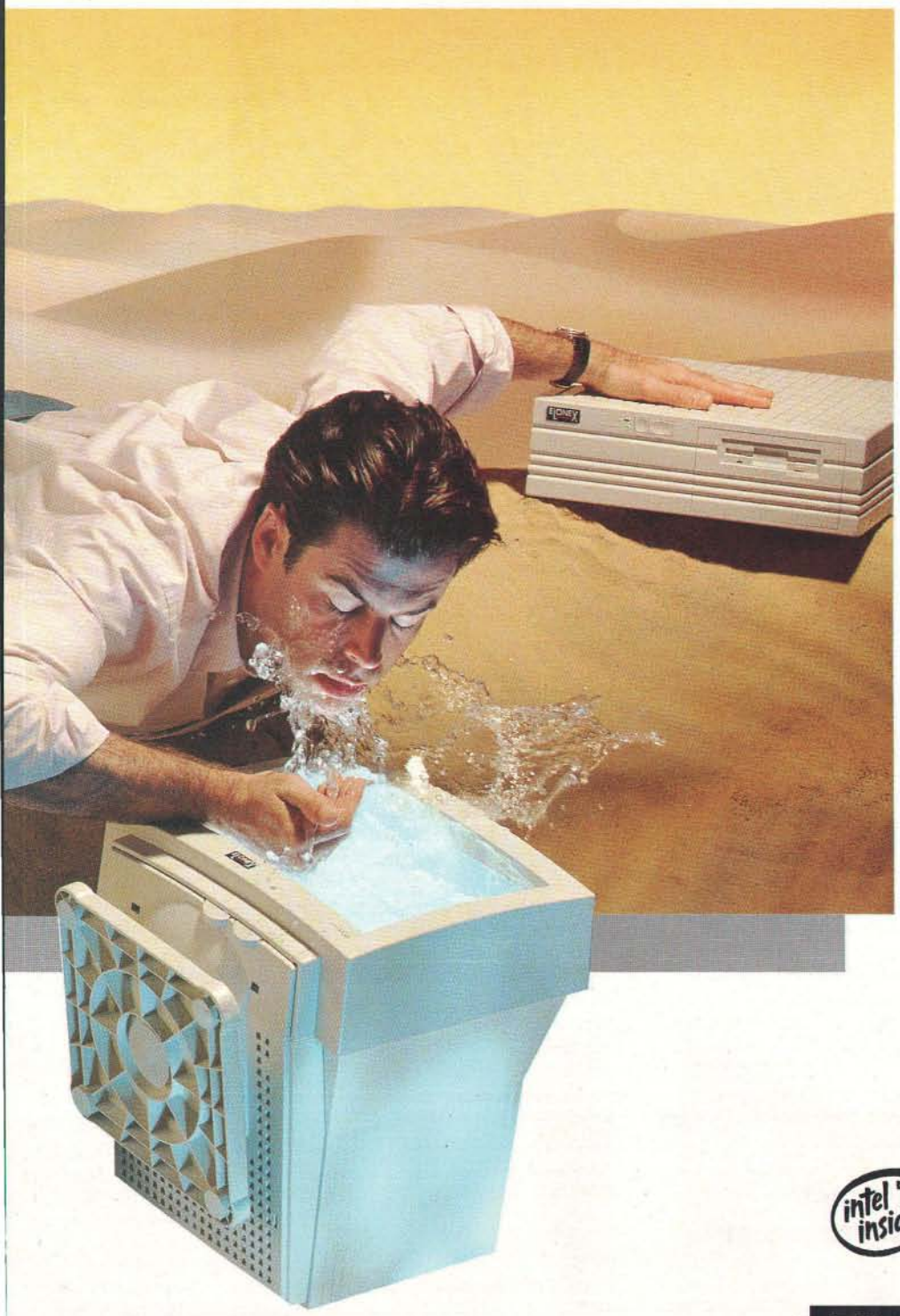

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Selected 486 PCs pre-loaded with MS-DOS 5, Windows 3.1, Word for Windows 2.0, Excel 4.0, Powerpoint 3.0 and Microsoft Mail 3.0

SAMPLE 486DX2 CONFIGURATION

PC-466M Office PC

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Upgradeable 66MHz 486DX2 CPU

8MB RAM

200MB Hard Disk pre-loaded with MS-DOS 5, Windows 3.1, Word for Windows 2.0, Excel 4.0, PowerPoint 3.0 and MS Mail 3.0

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Intelligent Task Automation

Office Accelerator uses DDE and word processing macros to let you transport names, company names, phone numbers, addresses, notes, and other information from its integrated relational database (Phone Book) into letters, envelopes, labels, business forms, and faxes that you have composed within Word for Windows, Ami Pro, WordPerfect for Windows, or Lotus Write. In addition, the Office Accelerator Phone Book accepts information, such as vendors, customers, investors, friends, parties, Christmas cards, and birthdays, that can serve as the basis for future searches.

The Multiples feature lets you do a mail merge; print multiple envelopes, labels, and forms; and fax to multiple recipients. With the Reports feature, you can print out phone lists for all or any part of your Phone Book, as well as modify and create your own reporting formats.

The Create/Edit feature lets you create or modify any letter, label, envelope, or form template using all the tools available in your word processor. You can add text, clip art, or scanned images; copy, add, or move merge fields for form letters and memos; and save the new templates for future use.
Price: $129.
Contact: Baseline Data Systems, Inc., Torrance, CA, (310) 214-8528; fax (310) 214-8529.
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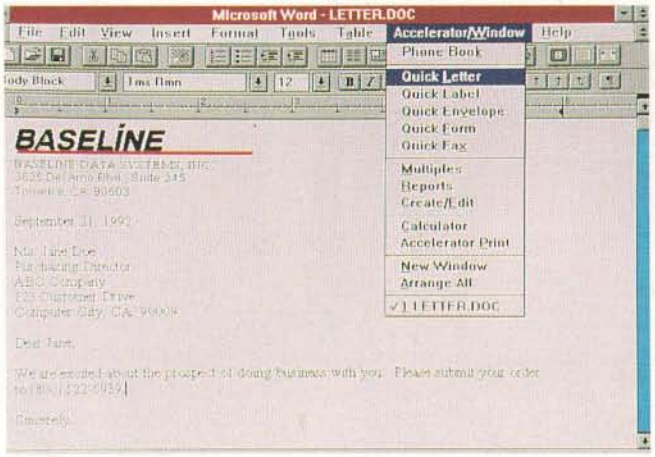

Office Accelerator's menu appears on your computer screen within the menu of your word processor.

PostScript Fonts for WordPerfect

The PrimeType package provides WordPerfect users with on-the-fly, transparent access to 20 PostScript language fonts handpicked from the Adobe Type Library. PrimeType makes your WordPerfect printing device independent, so you can print WPDOS or WPWIN documents on most dot-matrix, ink-jet, PostScript, or laser printers without reformatting. The PrimeType package includes Adobe Type Manager for Windows, so you can also use the package's fonts with your Windows applications.
Price: $99.95.
Contact: LaserTools Corp., Emeryville, CA, (800) 767-8004 or (510) 420-8777; fax (510) 420-1150.
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Contact Management

With features such as group scheduling, remote transfer synchronization, user-definable screens and fields, unlimited additional contacts, and five levels of security, GoldMine 2.5 may be the contact management package you've been looking for. The software for the PC lets you instantly retrieve, review, and analyze each recorded activity and view activities in list, statistical, or graphical formats.

The group-scheduling features let you quickly schedule users and resources, finding available times automatically and with RSVP verification. The new Remote Transfer Synchronization feature updates remote GoldMine systems with any changes, including notes, history, calendar, and messages, on records at the field level. With user-definable screens and fields, each department can create a different user screen suited to its needs.
Price: Single-user version, $295; five-user network version, $895.
Contact: Elan Software Corp., Encino, CA, (818) 999-9872; fax (818) 999-9903.
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A Desktop Calendar

Calendar Wise is a multi-subject planner/tracker that simulates a calendar on your PC. The package offers 100 calendars (10 lists with 10 calendars each) that let you keep unrelated planning separate. You enter information using recurring yearly, monthly, weekly, daily, and movable frequencies (e.g., second Tuesday of the month). Calendar Wise lets you change the calendar format so that you can view different numbers of weeks, and you can reference multiple calendars at once to be displayed or printed together.
Price: $25.
Contact: Blue Cannon Software, Charlotte, NC, (800) 779-0850 or (704) 398-0850; fax (704) 398-0928, ext. 22.
Circle 1303 on Inquiry Card.

Unix-Based Communication

If you are a Sun Sparcstation user, Power Base can help you manage your contacts and appointments. The communication system lets you streamline telephoning, faxing, E-mail, and postal and express mail tasks to your needs. The system reminds you of important dates and obligations and highlights critical action items and time lines in contact records. In a workgroup, department, or company, everyone can share information while maintaining separate confidential databases.
Price: Single-client license, $395; server license, $995.
Contact: The Bristol Group Ltd., Larkspur, CA, (415) 925-9250; fax (415) 925-9278.
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The Evolution of CAD

From the beginning of time, we have tried to express ourselves through graphics.

the begin-
ing of time
people had
use primi-
tive design
tools for
eating any
type of
graphics.

In the 15th Century design tools were quill ink pens and crude styles of paper.

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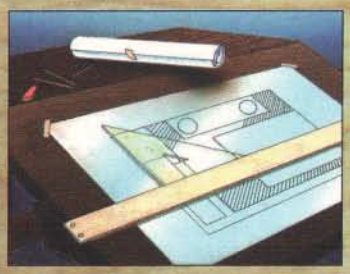
Faster and easier to use than AutoCAD!

By the 18th Century we had advanced to the drafting table with T-squares, and the dreaded eraser.



In the 20th Century the first CAD programs were very slow and extremely difficult to use, not to mention the expense of buying them.

PC MAGAZINE EDITORS' CHOICE December 17, 1991 CAD 2-D, Ver. 5.0

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DesignCAD Professional is the only complete CAD solution. It's 6 packages in one!

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- **DesignCAD 3D** gives you the power to create and manipulate solid or wireframe objects with quick and easy commands. Render your designs with outstanding photorealistic color!
- **Video Training Tapes** for DesignCAD Professional, are produced in a state-of-the-art facility using award winning writers, and professional technicians. Using these video tapes will assure you of learning faster with higher retention, while becoming more productive!
- **SmartEST** quickly generates a spread sheet from your DesignCAD drawings so you may estimate cost, and do take-offs for accurate bidding.
- **Symbol Libraries** contain over 6700 pre-drawn Architectural and industry standard symbols. These alone will save you a tremendous amount of time and money!
- **ScanPRO** converts (Raster to Vector),scanned images into files that can be read by DesignCAD or most other CAD programs.

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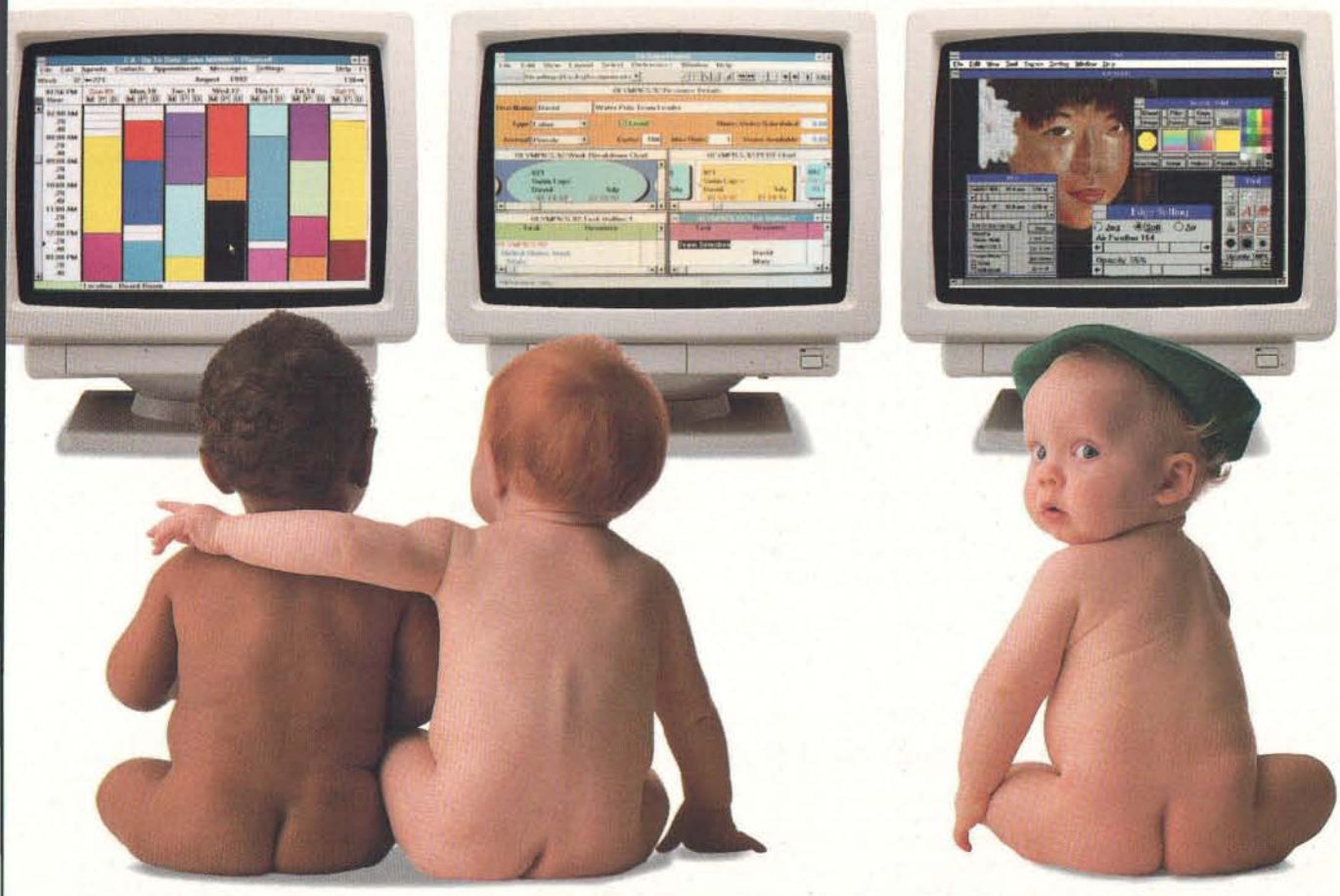

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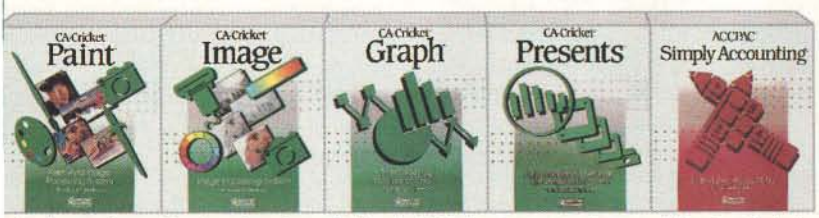

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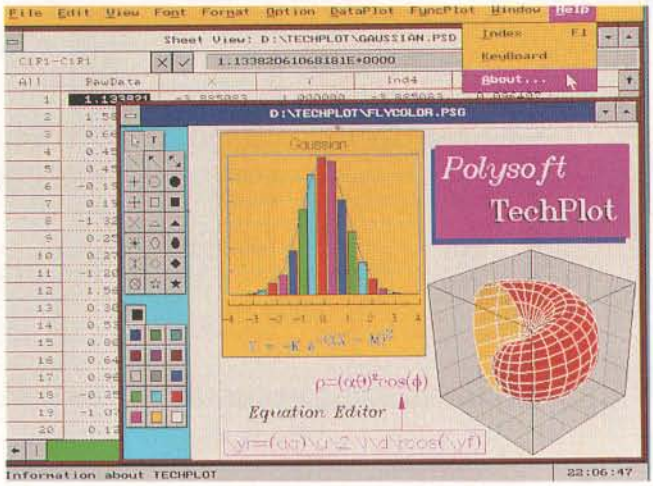
Process and Plot Data

TechPlot, a technical data processing and plotting package for the PC, performs statistical analysis, data transformation, digital signal processing, nonlinear parameter fitting, and experimental model development. In addition, the software provides a plot-editing toolbox and a wide variety of 2-D and 3-D plot types. With TechPlot you can place multiple coordinate systems, axes, and plots on one page.

You can exchange data with most popular spreadsheet file formats and use TechPlot to produce publication-quality graphics output on dot-matrix and laser printers, plotters, and slide makers. TechPlot can also produce color EPS, CGM, TIFF, BMP, PCX, and HPGL files.
Price: $449.
Contact: Polysoft, Salt Lake City, UT, (801) 485-0466; fax (801) 485-0480.
Circle 1306 on Inquiry Card.



TechPlot is a technical graphics software package that runs completely in graphics mode in the DOS environment.

Study Chemical Elements

Chemistry Works, The Computerized Periodic Table, streamlines on your PC the processes of identifying, cross-referencing, comparing, and studying detailed information about all 108 elements. The software features atomic number, radius, volume, and weight; boiling point; covalent radius; crystal structure; density; electrical conductivity; electron configuration; electronegativity; heat of fusion; melting point; name; oxidation state; specific heat; state (solid, gas, or liquid); symbol; and thermal conductivity.
Price: $69.95.
Contact: Software Marketing Corp., Phoenix, AZ, (602) 893-2400; fax (602) 893-2042.
Circle 1307 on Inquiry Card.

An Observatory on Your Desktop

Epoch 2000 offers amateur astronomers a desktop planetarium, image-processing capabilities, and access to the future Remote Telescope Network. The package, for Windows 3.0, can display the sky from anywhere on Earth at any time between 4713 B.C. and 10,000 A.D.

The desktop planetarium displays 45,000 stars; 13,000 clusters, nebulae, galaxies, and other deep-sky objects; 7700 asteroids; and 650 comets. You can zoom in to a field of view less than 1 second of arc, measure angular distances between stellar objects, and determine each star's magnitude and velocity.
Price: $329.
Contact: Farpoint Research, Downey, CA, (800) 858-9795 or (310) 861-6606; fax (310) 862-1546.
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New Features for PC-OPT+

Electrical Engineering Software has added support for simultaneous optimization in more than one domain and PC-OPTlib, a discrete component library of more than 8500 fully characterized parts, to PC-OPT+, its electronic circuit optimizer for the PC. PC-OPT+ performs rapid, SPICE-like simulation and can change selected component parameters to make circuits meet your performance specifications.
Price: $950 and up.
Contact: Electrical Engineering Software, Inc., Santa Clara, CA, (408) 296-8151; fax (408) 296-7563.
Circle 1309 on Inquiry Card.

Residential Floor Plans

Designed as a Windows application, Chief Architect can quickly and accurately produce a floor plan for an entire residence or an addition to a home. The object-oriented system uses architectural entities (e.g., walls, windows, doors, and cabinets) and can handle diverse processes such as dimensioning, placement of electrical outlets, and placement of fixtures, cabinets, doors, windows, and appliances.

The software's symbol library includes predrawn standard residential building components, as well as graphics for finishing touches such as furniture and cars. Chief Architect lets you export all or parts of your plan to Windows-based word processors and desktop publishing programs, as well as to CAD systems. You can also print or plot your plans to any scale.
Price: $495.
Contact: Advanced Relational Technology, Morgan Hill, CA, phone and fax (408) 776-0310.
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Analyze Experiments

Jandel Scientific designed its SigmaStat statistical package for scientists who need to efficiently compute statistics to analyze real-world experiments. SigmaStat can handle missing and unbalanced data and automatically creates detailed reports of all statistical procedures.

SigmaStat's Advise command helps you select the most appropriate statistical procedure for your data and then automatically performs the test. You can use SigmaStat with SigmaPlot to create publication-quality graphs.
Price: $395.
Contact: Jandel Scientific, San Rafael, CA, (800) 874-1888 or (415) 453-6700; fax (415) 453-7769.
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CORELDRAW 3.0

THE FIRST ALL-IN-ONE GRAPHICS SOFTWARE

In the information-packed '90s, good graphics are more important than ever to get your message across quickly and effectively. And now it's easier than ever to use graphics — with CorelDRAW 3.0! Everything you need is in one value-packed box. There is no longer any need to buy separate illustration, charting, painting, and presentation packages. CorelDRAW 3.0 does it all with unmatched power and ease-of-use! And, as an unprecedented bonus, Corel has included a CD-ROM with over 14,000 clipart images and over 250 fonts! You'll get fingertip convenience for software that would otherwise occupy over 500 floppy disks and cost thousands of dollars.

Outstanding Reviews!

" CorelDRAW remains the easiest-to-use graphics product on the market...the ultimate graphics bargain! "

PC Magazine, August, 1992

"CorelDRAW – ALL THAT MOST PEOPLE WILL EVER WANT in the way of a graphics software..."

William D. Harrel, Windows Magazine, July, 1992

"Business users who need a wide variety of graphics functions shouldn't pass up this package. It is an amazing bargain."

Luisa Simone, PC Magazine, August, 1992

" CorelDRAW 3.0 is without doubt the most powerful, feature-laden, and best value for money graphics systems for Windows, at any price point. Full stop, end of discussion."

Jon Honeyball, Windows Magazine UK, August, 1992

"Endowed with paint, chart and presentation capabilities, this upgrade of the leading PC draw package is a stunning example of increased power at a reduced price."

Christina Wood, PC WORLD, July, 1992

"It's hard to find a more value-laden offering. We rate the value as excellent."

Mike Heck, INFOWORLD, July 13, 1992

"Total relative value of CorelDRAW modules, clipart and fonts is $15,000."

John Butler, Seybold Report on Desktop Publishing, July, 1992

"CorelDRAW is a phenomenal bargain"

Michael Burgard, PC/Computing, July, 1992

Suggested retail price

$595

Outstanding Value!

Other companies need several packages to do what Corel does in one!

Company	Drawing/ Illustration	Charting/ Presentation	Photo-Editing	Fonts	Clipart	Total Cost
Micrografx	Designer	Charisma	Picture Publisher	251	3940	$1685
Software Publishing Corporation	Harvard Draw	Harvard Graphics: (Windows)	Not Available	62	1600	$1190
Aldus	Freehand	Persuasion	PhotoStyler	12	305	$1885
Corel	CorelDRAW!	CorelDRAW!	CorelDRAW!	256	14,000	$595

No wonder CorelDRAW is the world's best selling graphics software for Windows!

CORELDRAW!

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Compudyne is the PC manufacturing and direct marketing arm of CompUSA™, the Computer SuperStore (NASDAQ symbol; CUSA)—inventors of big volume, deep discounting PC retailing, and the largest chain of computer super stores in the country. Compudyne manufactures top quality, fully-supported computers as available from only the largest PC manufacturers at prices typically found only at garage shop clone houses.

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- FCC Class B certification

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386SXL/25	386 SXL- 25 MHz Optional 80387SX This years' model, 5.5 lbs. while supplies last	2 standard, 4 & 6 options	60	3.5+	$1,399 $52/mo*
386SXL/25	386SXL–25 MHz, Optional 80387SX	2 standard, 4 & 6 options	80 More MBs!	3.5+	$1,599 $59/mo*
386SL/25	Intel 80386SL–25 MHz, 64 K CPU cache Advanced SL power mgm't, Optional 80387SX co-processor	as above	80	3.5+	$1,799 $67/mo*
486SX/25	Intel 80486SX–25 MHz, Built-in 8K CPU cache	4 standard, 8 & 20 options	80	2.5+	$1,999 $74/mo*
486DX/33	Intel 80486DX–33 MHz, Built-in 8K CPU cache	as above	130	2.5+	$2,899 $107/mo*

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386DX/33 or 486SX/25	Intel 80386DX-33 MHz or Intel 80486SX-25 MHz, w/built-in 8K CPU cache	2 standard 32 max	80	as above	as above	$999 $37/mo*
486SX/25	Intel 80486SX-25 MHz Built-in 8K CPU cache	as above	80	1.2 & 1.44	16 bit SVGA card, 14" 1024 x 768 SVGA Color Monitor	$1,199 $44/mo*
386DX/33 CACHE	Intel 80386DX-33 MHz 64K CPU cache	4 standard 32 max	120	as above	16 bit SVGA card & Hi-Color Support 14" 1024 x 768 SVGA, .28 Interlaced Color Monitor	$1,399 $52/mo*
486SX/33	Intel 80486SX-33 MHz 8K CPU cache	as above	120	as above	as above	$1,499 $56/mo*
486DX/33 CACHE	Intel 80486DX-33 MHz 128K CPU cache	as above	120	as above	16 bit SVGA card, 1MB Video RAM & Hi-Color Support, 14" 1024 x 768 SVGA Non-Interlaced Multisync Color Monitor	$1,799 $67/mo*
486DX/50 CACHE	Intel 80486DX-50 MHz 128K CPU cache, True 50 MHz CPU	as above	120	as above	as above	$1,999 $74/mo*
486DX2/66 CACHE	Intel 80486DX2-66 MHz, 128K CPU cache New Double Clock CPU	8 standard 32 max	200	as above	16 bit SVGA, Superfast Windows, Accelerator card, 1MB RAM, 14" 1024 x 768 SVGA Non-Interlaced Multisync Color Monitor	$2,499 $93/mo*

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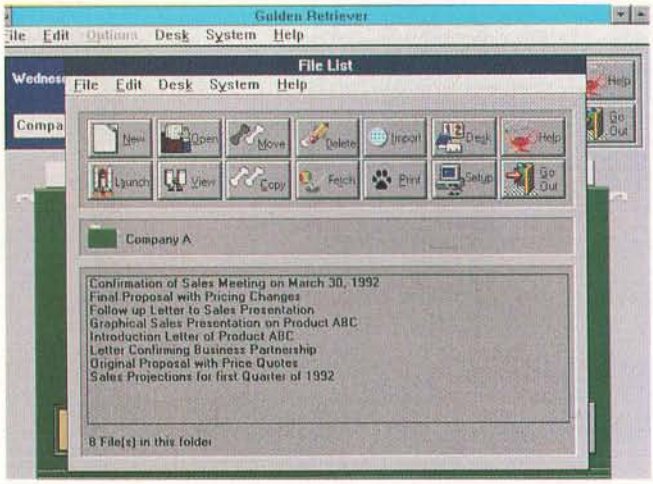
Price: $99.
Contact: Above Software, Inc., Irvine, CA, (800) 344-0116 or (714) 851-2283; fax (714) 851-2285.
Circle 1312 on Inquiry Card.



Golden Retriever includes a Desk button that gives you access to the Windows Control Panel, Card File, Calendar, Calculator, Notepad, Clock, PaintBrush, Microsoft Write, games, and other utilities.

Mac Multimedia Tools

Interactive Media's Special Delivery and Media Cataloger for the Mac help you present or communicate information using interactive digital multimedia. Special Delivery integrates existing graphics, pictures, movies, and sound into interactive multimedia. Media Cataloger, a stand-alone application, organizes, finds, and retrieves graphics, pictures, movies, and sound in formats that you can use in other applications.
Price: Special Delivery, $399; Media Cataloger, $99.
Contact: Interactive Media Corp., Los Altos, CA, (415) 948-0745.
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Lineas Informationstechnik offers SGIscan and CADview, two software packages for use with workstations such as those from Silicon Graphics, Siemens, and Bull.

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Price: SGIscan, $3700 (about 2500 deutsche marks); CADview, $6216 (starts at 4200 deutsche marks).
Contact: Lineas Informationstechnik GmbH, Braunschweig, Germany, +49 531 380 11 40; fax +49 531 380 11 59.
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IronClad is a high-end security and antivirus program for DOS-based PCs and networks. The program lets you apply attributes to drives, subdirectories, users, and even individual files to suit your security requirements. It prevents viruses without the need for upgrades; performs transparent file encryption; and prevents execution of programs from any source, including disks, removable drives, or CD-ROM drives.

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Contact: Silver Oak Systems, Inc., Silver Spring, MD, (301) 585-8641; fax (301) 588-6484.
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Contact: Lucid Corp., Dallas, TX, (214) 994-8100; fax (214) 994-8103.
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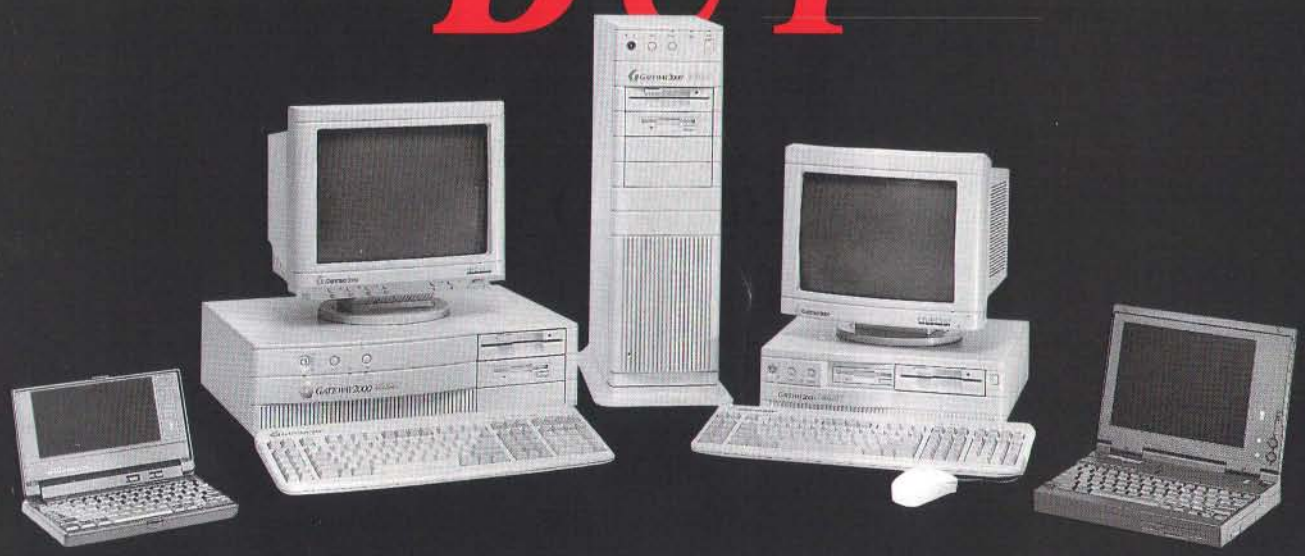

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JERRY POURNELLE

A COMPUTER IN THE HAND

Palmtops and PCMCIA at Chaos Manor, a look at the virus scene, and a trip to Korea

Another month on the road. I think they're trying to kill me. First it was Denver, as guest of the International BBS and Electronics Communication Conference, or IBECC. No sooner was I back than I was off to a science conference in Korea. Before that was over, I found myself in the Olympic stadium watching the Rev. Moon marry 25,000 couples, many of whom met for the first time that morning. Next Comdex, come ask me about *that* at the BYTE booth.

I hadn't been to Korea since the war. Of course, you expect things to change in 40 years, and I'd read a number of reports on the growing Korean economy, but I still wasn't ready for what I saw.

Seoul is a thoroughly modern city. People my age associate an Oriental capital with rickshaws and bicycles zipping along wide new boulevards that cut through areas of narrow streets and hovels. Not so here. All the streets are wide and straight, and if there are any hovels, they're well hidden from both the main highways and the extremely efficient elevated railway. I did not see one single rickshaw or bicycle. What I did see was cars and trucks, enough of them to create traffic jams all day, not just during rush hour; and this in a well-laid-out modern city. If they didn't have the elevated railway and subways, no one would get anywhere.

A number of economic forecasts put Korea ahead of Japan by the end of the century. I thought those ridiculous until last week. Now I'm not so sure. Korea is a nation of hardworking people who take education very seriously. It's also an orderly nation. Data point: there were 100,000 people in the Olympic stadium for the mass wedding. Granted, half were brides and grooms (all dressed alike, dark suits and white bridal gowns), and half those not being married were press, government officials, and invited guests; but in that crowd of over 100,000 people, I saw not one policeman and only a few dozen ushers. No one was armed. Four to 6 hours in the hot sun, and not one incident: no pickpockets, no demonstrators, no fights, no arguments, not even raised voices.

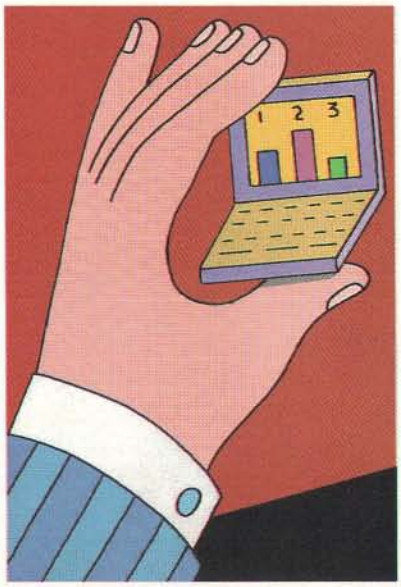
We think of Japan as competition, and rightly so, but we'd do well not to overlook Korea.

Gateway HandBook

It's nearly 12 hours each way from Los Angeles to Seoul, and more time in the lounges waiting to board. With my deadlines, I certainly didn't have any 24 hours to spare, so I was prepared to work on the flight. Korean Airlines has wonderful business-class service, and I had plenty of room to set up the Zenith Mastersport laptop.

I had a minor panic when I realized I'd left with the wrong mouse clamps. The Microsoft Ballpoint trackball is supposed to attach to your laptop; but there are two sets of clamps, and I'd brought the wrong ones. There was no way I could attach the Ballpoint to the Mastersport's case. It turns out, though, that you can lay the Ballpoint on the table next to the machine, and it works just about as well. I'd hate to do that holding the computer on my lap. The moral of the story is to check things out before leaving the house, which I already knew.

Korean electricity is 220 volts AC at 50 cycles. The hotel furnished a converter about the size of a large automobile battery charger. It worked fine, but I'm sure glad I didn't have to carry *that* in my luggage. Incidentally, given the falling dollar, most stuff—clothes, electronics, optics—in the upscale Korean department stores costs just about what it would in the Fashion Square Mall in Los Angeles.



I didn't get too far from the World Trade Center. I was in Seoul to attend a science conference and present a paper. The conference was excellent, organized as I like things: the papers were printed up and distributed beforehand, so most of us used our time for comments on other papers. Alas, a few attendees painstakingly read prepared papers. Worse, some Russians (and a few Italians and Chinese) weren't very fluent in English. There are few experiences in life that are more excruciatingly boring than to sit quietly and pretend to listen to someone who doesn't speak English read a paper that you've already read.

At least it's boring if you have nothing else to do. Of course, it would be rude to read a book no matter how badly the speaker reads; but it's flattering to see someone taking notes while you speak. In my case, I was actually working on what I would say when it was my turn, but no

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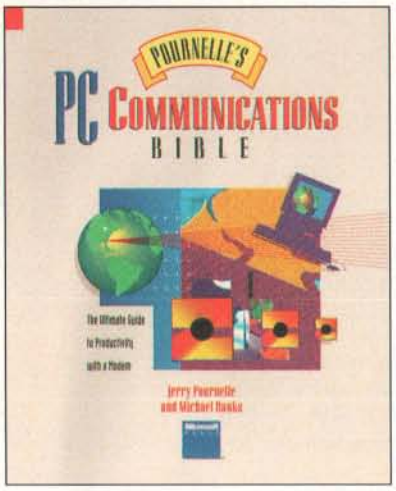

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one had to know that as I typed away on the Gateway HandBook.

The Korean trip served multiple duty: a really fascinating scientific conference, a chance to see the payoff from the Korean War—when I left, Korea was free but a wreck—and an excellent chance to test several palmtop computers.

It soon became apparent which one I liked most. The Poqet PC has some excellent points—my son Phillip still runs his division on the USS *Tripoli* with a Poqet, and he'd be lost without it. The HP 95LX also has its points. For that matter, there's a good bit to be said for the Atari Portfolio. However, all three are just too small for a touch-typist—or at least for *this* touch-typist. Phillip types two-finger style and swears he's a lot faster on the Poqet than on a full-size machine, and I believe him; and TV commentator Bruce Herschensohn can type two-fingered on his Atari Portfolio about as fast as I can touch-type. Me, though, I want to get my hands on them home keys; and I can do that with the HandBook.

Indeed, the HandBook was the hit of our conference. If I had been a Gateway dealer, I could have made a mint: I think everyone who saw the HandBook wanted one.

The HandBook isn't as small as the Poqet or the HP 95LX. Closed, it measures 10 by 6 by 1½ inches, making it too large to put into a coat pocket, where you might stuff the HP 95LX (or a Wizard, Boss, or Franklin Academy). You might get a Poqet into a very large pocket, but not the HandBook. You carry that in a shoulder bag or briefcase, or just as you would a book.

I've seen Portfolio users type with three fingers of one hand, with the thumb of the other working Shift and the space bar. They really fly along. I suppose that such a technique could be developed for the HandBook, but it's a bit large for that; where the HandBook shines is when you can set it on a table or on your lap. Then it's wonderful. The screen is backlit and large enough to see. The keyboard is excellent: quiet, good feel, decent layout, smaller than a standard keyboard, but large enough—a *really* good compromise.

I found I could type as fast on the HandBook as I can on the NCR Safari NSX/20. That surprises me. It's something about the feel of the keys, I think. I also found that I can see the screen through the bottoms of my bifocals; I don't have to put on my special computer glasses.

Understand, the HandBook is a 286-performance computer, with 1 MB of memory and a 42-MB hard drive. Unlike the Safari (which is one of the smallest and best notebook-size machines), it won't run Windows; but it will sure run any DOS programs you're used to. My HandBook came with Microsoft Works. I hadn't previously used Works much, but I found it nearly ideal in combination with the HandBook. The word processor is intuitive. So is the spreadsheet. Microsoft Works on the HandBook is a wonderful combination for a beginner, say, someone just going off to college; and I found it good enough for all my conference work, including using the spreadsheet and BASIC to do some quick computations at the conference while Professor Fred Singer of George Mason University gave us up-to-the-minute climate and temperature data.

There's no modem, but that wasn't a problem. I use a small Supra modem. The HandBook has a normal DB-9 serial port.

The other port on the HandBook is a parallel port; it looks like a very small Centronics connector. They furnish an adapter to turn that into the standard DB-25 parallel connector.

The HandBook comes with LapLink XL, a scaled-down OEM version of Traveling Software's LapLink Pro. Like LapLink Pro, LapLink XL will send itself to another DOS computer, such as the Mastersport. You need this, of course, because there's no floppy drive on the HandBook. They do sell an external floppy drive, but I don't have one yet. I presume it's like the Safari's external floppy drive, and I can't think of any reason why it wouldn't work properly.

I used the serial port and LapLink XL to peel all my work off the HandBook and onto the Mastersport. Incidentally, the HandBook off-loads files at high speed, but incoming was slow; I think I may have a noisy serial port, which gives me a lot of retry errors. But everything I wanted in the HandBook got there, while files coming out of the HandBook were no problem at all. Gateway assures me this is covered by the warranty, and they'll be glad to swap machines, but I'm off for another trip tomorrow—they *are* trying to kill me—and the thought of going to a science fiction convention without the HandBook to show off is appalling; which may tell you something about how much I like it.

I haven't yet tested the HandBook with BSE's external Flashdrive hard drive because installing the BSE software requires a floppy drive. I did connect the Flashdrive to the Mastersport, and I was then able to access it through LapLink as the Mastersport's D drive.

You can see where all this is leading: on trips, do I need any computer other than the HandBook? The first experiment will be tomorrow: I'm off for Florida, and I'm going to put the Mastersport, well padded,

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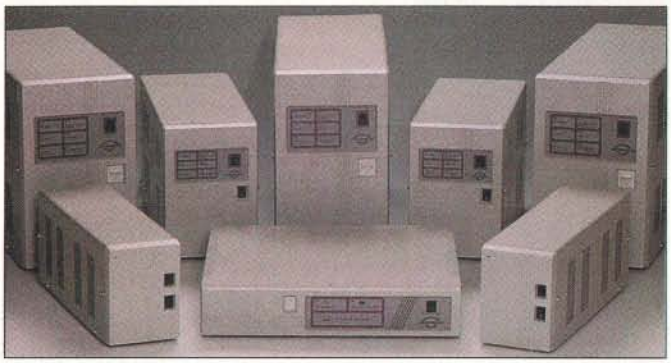

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into checked luggage. The HandBook will be the only machine with me on the airplane. Also in checked luggage will be the Supra modem and the Flashdrive with 100 MB of files and programs. We'll see just how much I use which machine and when.

PCMCIA

The only problem with the Gateway HandBook is that it doesn't have a PCMCIA slot. Alas, that's a serious deficiency. Poqet (which is now Fujitsu) did a lot of pioneering work on PCMCIA, and the Poqet has *two* such slots, which is a great idea. The Safari has one. So does the HP 95LX palmtop. Alas, the Franklin Academy and Atari Portfolio don't have one, although they have something proprietary that's like it. The Zenith Mastersport doesn't have PCMCIA, and it needs it.

For those who are wondering what in the world a PCMCIA interface is, it's a gizmo that accepts a PC card about the size of a baseball card, but about 3 millimeters thick. The whole thing is very small, since the only moving part is the mechanical button to eject the PC card. Internally, the interface connects directly to the machine's I/O bus. The result is that the computer can see the PCMCIA device as a hard drive holding up to 20 MB (at present; larger cards may be coming) of very fast nonvolatile read/write memory.

You can take the card out and transfer it and its files to another computer equipped with PCMCIA (which is why PCMCIA compatibility is important, and it's unfortunate that the Atari Portfolio doesn't have it). PCMCIA makes it really simple to save your work and remove it from the machine without a floppy drive; or to transfer up-to-the-minute stuff, such as databases, calendars, and last-minute reminders.

You can also put programs on it. Phillip has WordPerfect on a PCMCIA card on his Poqet; in the other slot he has a memory card. Understand, you can change those cards at any time, with the same ease that you change floppy disks. I don't use WordPerfect, but I do use Derive, a mathematics program, and that's available in PCMCIA format now. So are many other programs. I doubt it will be long before all your popular software programs are available that way—and, for that matter, since PCMCIA is a read/write medium, there's nothing to prevent you from making up your own card library of programs you want to have handy on trips.

A new specification from the PCMCIA extends the PC card standard to accommodate other peripheral devices (e.g., modems, network adapters, and even disk drives) on a PC card (see this month's Under the Hood, "The PCMCIA Redefines

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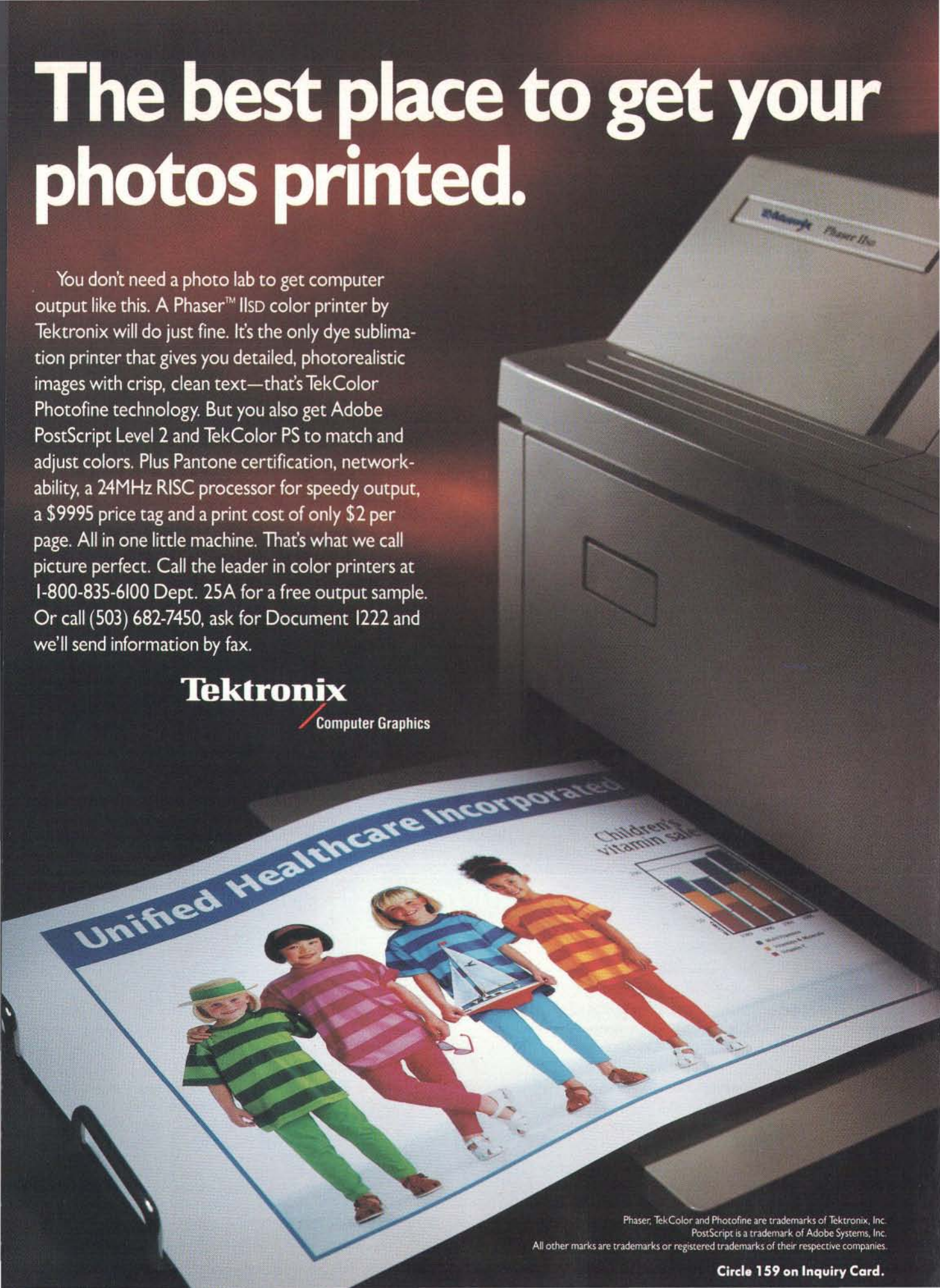

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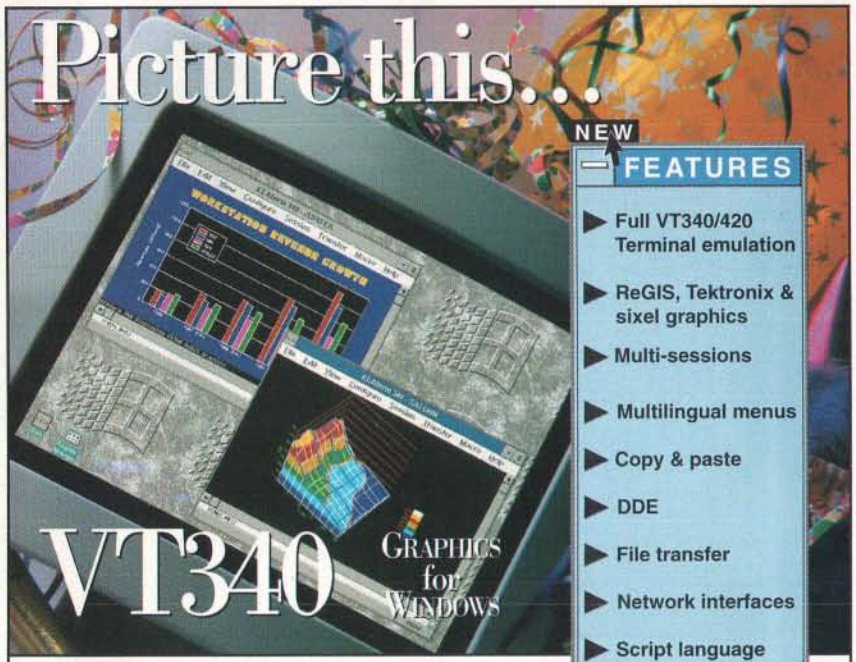
Portability," for more details).

It's my guess that within a year every respectable laptop and palmtop will have PCMCIA; and within three years, most new desktops will have them.

It's relatively easy to retrofit a desktop machine with PCMCIA; you insert a bus card and connect it to the PCMCIA drive, which can mount internally. It's a bit like adding an extra floppy drive to your system. Since PCMCIA connects to the bus, it's not quite so easy to retrofit cardless computers, but Trantor has made SCSI work through the parallel port; and I've seen ads for PCMCIA drives to connect to the parallel port. I suppose those won't be as fast as a DMA connection, but they should work. I'll get one and find out.

Gateway is aware of the growing interest in PCMCIA, and I'm sure that not long after you read this, it will be offered as an option for the HandBook.

Anyway: the bottom line is, I love that little HandBook. Highly recommended.



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HP 95LX

It's powerful. It has a PCMCIA slot. It's well supported. It's small. It's the latter that limits its usefulness to me: it's *too* small. This is one of those machines that you'll either love or hate because of the form factor. If you can manage two-finger typing and can live with a small screen, this is a real computer you can truly put in your pocket.

It's a bit tricky learning to use it, but actually it's easier than learning the Wizard or the Boss or one of the other pocket date/calendar/notebook devices. After all, the HP 95LX is really a tiny PC running programs under DOS. There are buttons that do some fancy switching among programs, and some programs such as Lotus 1-2-3 are preloaded into ROM for you; but through the magic of PCMCIA, you can run almost any program you can get onto a desktop PC. The PCMCIA slot is the A drive, and you can load programs from there as well as save data to it. There are screen limits. The HP 95LX's screen is 16 rows by 40 columns. It's not backlit.

One very innovative feature: an infrared communications port. At the moment, that will talk only with a properly equipped HP LaserJet laser printer; but it's an interesting feature other palmtop makers should study.

There are keyboard limits. The keys are in a QWERTY pattern, but the numbers are in a number pad to the right rather than across the top. Across the top are dedicated keys that jump to programs such as the phone and memo applications, a full HP calculator, and Lotus 1-2-3, all of which you can jump to at any time. (Above those keys is a line of function keys: F1–F10.) The colon and semicolon, left and right arrows, and the like are Shift-numbers, while special characters (e.g., #, $, and %) are Shift-symbol keys. All these keys are tiny chiclet affairs; it's meaningless to talk about their feel. The space bar is about 2 inches wide. There are Alt and Control keys. The whole thing is very small. After all, the entire unit measures only 6¼ by 1 by 3¼ inches when closed.

And that's both the strength and weakness of the HP 95LX. It's small enough to put in your pocket and considerably more powerful than a Wizard or Boss. You can add tons of accessories to make it work better, communicate better, and hold more data. Add an external hard drive. Add an external modem. What you cannot do is change its fundamental size.

The Safari has got notebook computers down to about as small as they're going to get and still have a full-size keyboard. Get any smaller, and it's not a notebook; it's something else. HP has

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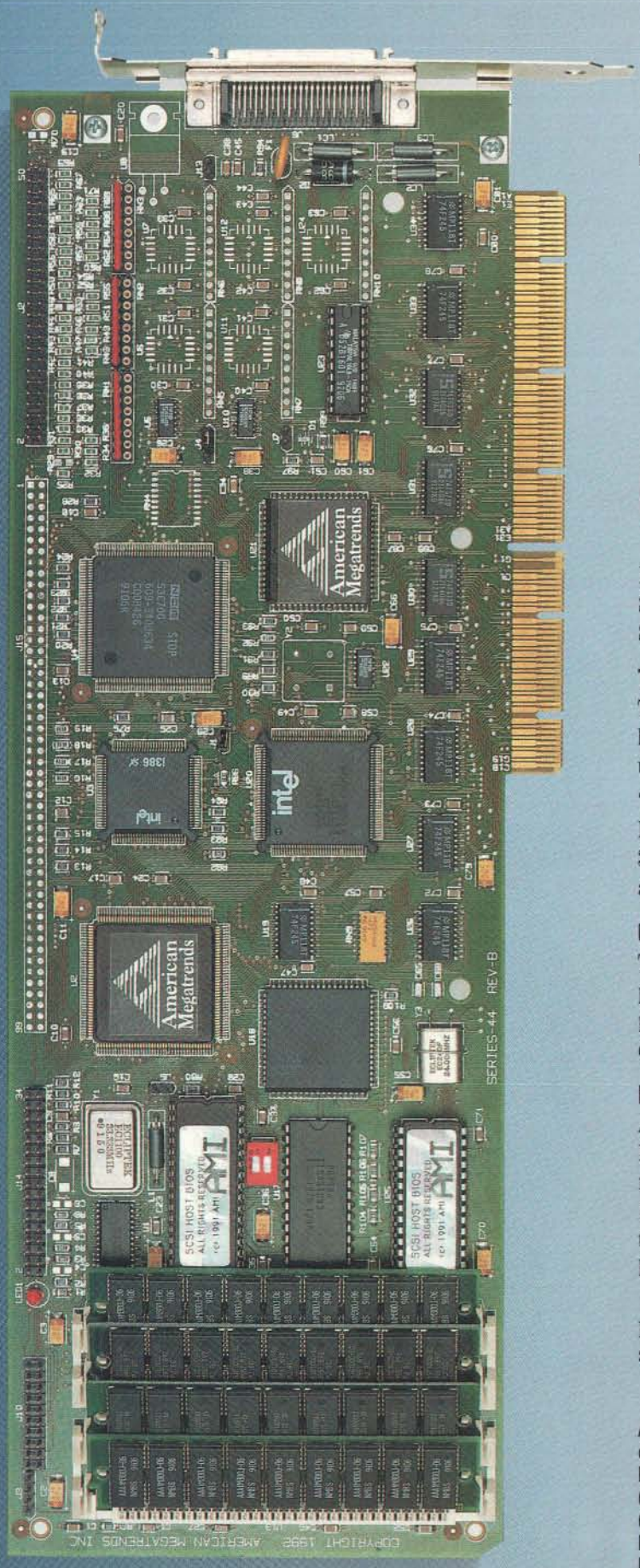

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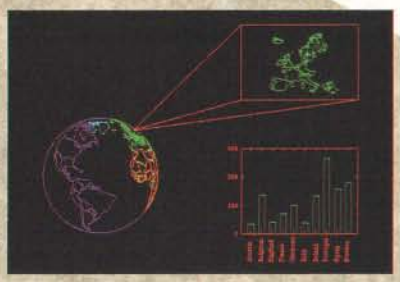

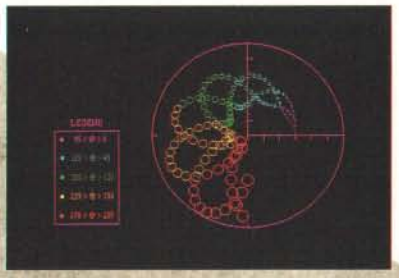

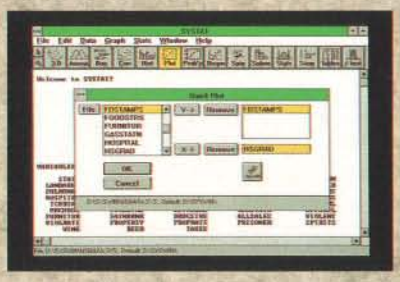

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done about the same thing here. Smaller is a stunt. It looks as if they've gone about as far as folks can go....

If you have any interest at all in a tiny computer, this is the one you want to look at. The PCMCIA slot will keep it up to date and make it easy to add software. There's already plenty of support: to see just how much, get a sample copy of the *HP Palmtop Paper*, a bimonthly 40+-page 8½- by 11-inch newsletter with articles on using the 95LX and ads for nifty accessories and programs. Contact Hal Goldstein at P.O. Box 869, Fairfield, IA 52556, (515) 472-6330.

I still prefer the Gateway HandBook, but then I deal with words more than numbers; if your life revolves around Lotus 1-2-3, or if all you want is an electronic calendar and appointment book, you will probably love the HP 95LX. For that matter, I don't intend to let go of mine. Sometimes I don't want to carry a shoulder bag.

Meanwhile, the Poqet PC is a compromise between the really tiny HP 95LX and the nonpocketable Gateway HandBook. One of these ought to fit any need.

More on these machines another time.

The Virus Scene

Don't panic. I mean that literally. There are a lot of people out there who want to scare you into buying expensive antivirus software. Mind you, some of that software is very good. The question is whether you need it.

The answer for most of you is, probably not. There are a growing number of reported cases of viruses appearing "in the wild" (as opposed to being seen in laboratories), but the actual number of people harmed by them is small compared to the population of computer users; and this despite the growing sophistication of viruses, and the growing number of people who think it a clever idea to write one and release it to the world.

The main reason there's so little damage from computer viruses is that there are a number of dedicated people collecting viruses, analyzing them, and writing programs that find and get rid of the pests; and that presents a dilemma. Virus analysis is expensive, and it's often a thankless task since the usual result of analysis is to show that the virus wasn't much of a threat.

Most "wild" viruses can be detected with simple scanners available as freeware or shareware on most computer BBSes. If you take elementary precautions and use one of those scanners before installing new software, your chances of being harmed by a virus are very low.

Unfortunately, things change, and sometimes the threat is all too real. The monthly *Virus News International* ($120 per year from Ontrack Computer Systems or £178 per year from Virus News International, Berkley Court, Mill St., Berkhamsted, Hertfordshire HP4 2HB, U.K., +44 0442 873033) recently published an interview with the Central European virus writer often called "Dark Avenger." It's chilling. The interview was done through a BBS, and there was apparently no chance of finding the true name of this chap; but a number of items left the editors of *Virus News International* in no doubt that they were talking with the actual author of some of the nastiest viruses ever found in the wild. The man is clearly brilliant. He also has no sense of remorse. I don't know his reasoning, but it's my guess that he figures that he's improving the breed, somewhat in the way that wolves improve caribou herds.

He is not the only person with considerable skill who seems dedicated to doing as much harm to the computer community as possible; and the viruses seen by the editors at Virus News International are becoming increasingly sophisticated. For individual users who use sane backup procedures and reasonably regular detection scans, this still isn't a great threat.

However, imagine this scenario: you are part of a large organization absolutely dependent on your database, which is available to hundreds of employees through your network. One day you discover that something is wrong with the data: something just doesn't make sense. A closer look reveals your whole database is corrupted. Sophisticated investigation detects a virus. It has been operating for *months*, never manifesting itself, and confining its activities to making random changes in your database.

It has been operating long enough that many—perhaps all—of your backup files are also contaminated.

What would it cost you to recover? Could you recover at all?

Of course, that's not likely to happen to you; but it's possible, and the less you know about the virus scene, and the fewer clever people who are working to detect and eliminate viruses before they can do this, the more possible it becomes.

And thus I recommend that if your company can afford it, you should subscribe to one or both of the English virus news

We didn't start the PC price war.

(We'd never back down on quality.)

services, *Virus News International* or *Virus Bulletin* ($395 from Virus Bulletin, Ltd., 590 Danbury Rd., Ridgefield, CT 06877, (203) 431-8720. In Europe, the address is 21 The Quadrant, Abingdon Science Park, Abingdon, Oxfordshire OX14 3YS, U.K., +44 223 555139). Both are published by organizations that sell antivirus software. Virus News International is part of S&S International Ltd., the outfit that distributes Dr. Solomon's Anti-Virus Toolkit, the program I heartily recommend. Monthly updates to the Toolkit come with your subscription.

Virus Bulletin presents a different viewpoint. It's quite readable, and one of its functions is to keep other virus prevention services on their toes. It, too, deserves support.

Neither of these is anything like cheap. They don't come in fancy wrappers, they are not printed on slick paper, and there aren't any pretty pictures. They're pretty thin, for that matter. Are they, then, worth their cost? In my judgment, resoundingly yes; we would be in sad shape without them. If they didn't exist, we would pretty soon have to create them, and we would probably do that in a panic, possibly as a government agency. That would likely end up costing us considerably more than the industry pays with tax-deductible subscriptions to these services.

S&S and Virus Bulletin are not part of the "scare them into buying virus protection" school. There are some firms that produce good programs but are just awful that way.

As to why support these two as opposed to excellent organizations such as Symantec (producer of Norton AntiVirus), it's a judgment call, and I might easily be wrong. I've watched all the antivirus groups for several years now, and I think the British groups are more on top of the situation than the several good-to-excellent American research/publishing firms. This may be because most of the dangerous viruses lately come out of the former Evil Empire (and you could write a book about why *that* should be so), and the British groups are closer to the front lines. They tend to see the new viruses first.

Whatever. I don't insist that you support the companies I recommend here. I do suggest strongly that if your company would be greatly harmed by virus infections as I described above, you support *some* organization that engages in virus collection and analysis. Don't be a free rider.

We didn't start the PC price war.

(Price isn't everything.)

Ramas/age

One of the things we discussed at my meeting in Seoul was population trends; so when I came back home, I decided to play around with some population models to see what's likely for my children and grandchildren. After all, the total population and its age distribution will be one of the most important parameters setting the quality of life 20 and 30 years from now.

Moreover, population trends are hard to change. If we started right now on a campaign to produce more young people to enter the work force, it would be 18 years before *any* of our new products came online. The U.S. inevitably faces an aging population: fewer working-age people and vastly more retired people. It looks to me as if our choices are very limited: increase productivity, or have a declining standard of living. Or both.

Unfortunately, most increases in productivity are eaten by new measures, such as the Clean Air Act, which mandates that all coal plants have stack scrubbers, even though exhaust gas from burning Western coal goes into the scrubbers with less sulfur content than Eastern coal gas *leaves* with. It may be a good thing to use up productivity increases this way rather than investing in future productivity gains; but we ought to be aware of the consequences, too. It's my opinion that most of the productivity increases made possible by small computers have disappeared into increased regulations.

In any event, Ramas/age lets you do population modeling; for those familiar with the lingo, you set up your own Leslit matrices, and you put in stochastic variations. For those unfamiliar with those terms, it's all explained in the documents. You don't have to be a sociologist to play around with this and get a feel for the age distribution of the American population over the next century. It may scare the daylights out of you.

Writer's Toolkit for Windows

I've had this around for a long time without installing it, because I didn't think I needed it. After all, my word processor is Q&A Write, which comes with an excellent spelling checker as well as Word Finder. I also have the Definitions Plus implementation of *The American Heritage Dictionary*. If I want to check grammar, I have Grammatik V. All those programs work within Q&A Write. Furthermore, if those aren't enough, I have Microsoft Bookshelf on a CD-ROM. I didn't figure that I would

ever need Writer's Toolkit.

That's true enough as long as I'm working at Chaos Manor with my big Cheetah 486 and all its accessories; but on the road it's different. Laptop machines are slower and have smaller disk drives; and besides, who wants to install all those different programs on a laptop? So, last time I went on a trip, I carried Writer's Toolkit along just to see how it would work.

It works fine. It's easy to install, and all the parts work together. I still like Grammatik V better than the Houghton Mifflin Grammar and Style Checker, but the latter is good enough. I still like Definitions Plus better than the Writer's Toolkit implementation of *The American Heritage Dictionary*, but, again, Toolkit is good enough; and with Toolkit, I get the *Columbia Dictionary of Quotations*, which, once again, isn't as nifty as the *Bartlett's* in Microsoft Bookshelf—but it's good enough.

Which is the bottom line. If you're a professional wordsmith, you may want to build up your own toolkit; but for something you can just drop into your computer and start using immediately, Writer's Toolkit will do quite well, thank you. It's great for students: easy to use, which encourages them to use it often. I also know professional writers who like Toolkit just fine and use it all the time. I'll probably go on using my collection of tools here at Chaos Manor, but Writer's Toolkit goes onto all my portables. Recommended.

People are making money with specialized BBSes.

The BBS Scene

There's so much going on here that it's silly even to try to cover it all. The important thing is that people are making money by setting up specialized computer BBSes. Indians in North Dakota are selling art over BBSes using NAPLPS (North American Presentation-Level Protocol Syntax) protocols. The software for creating graphical art that can be distributed over BBSes is now shareware. The Big Sky Telegraph educational network is changing the way education is done in the Dakotas.

It was predictable, of course, but it's all happening faster than you'd imagine.

David Hughes, Col. USA (Ret.), operates both free and commercial services. On his BBS, Old Colorado City ((719) 632-2658, 1200 to 14,400 bps, V.32, V.32bis), you can find out more about shareware graphics systems from him in 10 minutes than you can from me in a lifetime. He set up Big Sky Telegraph, too.

Write IBECC (P.O. Box 486, Louisville, CO 80027). Say hello to Debbie Weisblatt and ask for a copy of their newsletter. Since IBECC is a nonprofit organization, slip a couple of bucks in the envelope to help them with postage expenses. If you're interested in the flavor of what's happening in the BBS world, this is a good way to get started. You might be amazed at what you find out.

To get in on it, and to toot my own horn, *Pournelle's Communications Bible* from Microsoft Press is no bad start. Since my coauthor Mike Banks did more than half

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(This is where we draw the line.)

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HEWLETT PACKARD

the work on the book, I don't feel too bad about recommending it.

Microsoft Operations Research

The word processor wars have been raging since the days of Electric Pencil and WordStar 1.0, and they show no signs of abating. A publisher will add a feature to a product; soon every other word processor must have that feature. Soon after that all the word processor programs are fat, complicated, and overgrown; and the feature wars continue even so.

Whatever else you can say about Microsoft, they do their homework. I spent an afternoon with the Microsoft Word program managers, and it's astonishing how much trouble they've been to in finding out just how people really use their word processing software. They went to user establishments and requested, "Show me the last thing you just created on a word processor. Now show me exactly what you did."

One result of that research was a considerable understanding of what features people really use, which don't make any difference, and which ones people would use if they understood how to do it.

The first product to be influenced by that understanding was the latest edition of Word for Windows integrated with Bookshelf. This is a smooth integration of two major and important products. I'm still in the process of restructuring computing at Chaos Manor, so although I have Word/Bookshelf up, it's not on my main machine. I'm still using Q&A Write to create text and then putting it into Word for Windows for a final edit and printing. That's likely to change.

The Word/Bookshelf integration is very good. It's still a bit slower than I like—with Definitions Plus, I get my dictionary definitions instantly—but CD-ROM drives are getting faster, and there's better caching software all the time. Fast and slow are relative to what you're used to: it's sure quicker to look up quotations and find entries in the *Columbia Desktop Encyclopedia* from the CD-ROM than to get up, get the print copy, and look things up.

I'm confident enough that we'll see a lot more improvements in Word that I'm making the time investment to learn Word for Windows; and I haven't regretted that.

Winding Down

We're still working on networks at Chaos Manor. It's not that it's so difficult; it's just that I'm not here enough, and when I am here, I have to work on fiction. We'll get to it Real Soon Now.

The book of the month is Freeman Dyson's *From Eros to Gaia* (HarperCollins, ISBN 0-06-039111-1, $22.95). I've always thought Dyson one of the sanest men I ever met, and this collection of essays on a dozen subjects ranging in time from the 1940s to the 1990s does not change my opinion.

The computer book of the month is *Inside the Norton Desktop for Windows 2.0* by Peter Norton and Reneé Gentry (Brady Books, ISBN 0-13-474503-5, $26.95). If you're a Windows user wondering if you want Norton Desktop, this will let you make up your mind.

The game of the month is the Strategic Studies Group's Carriers at War. I've always been interested in the Pacific War, and this is a good game/simulation. It's an all-new version of their popular oldie. The graphics are stunning.

As usual, I've run out of room, but not things to write about. We're continuing our investigations of OS/2. There is an Amiga show just after I get back from Florida; interesting things are happening.

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CorelDraw is improved yet once more, and the CD-ROM version is nifty. I've got a number of math programs, ranging from Derive to Mathematica, and with luck I can do some comparisons. Apple's Lisp is exciting Lisp programmers, and I have an evaluation by Steve Mitchell. We are also gathering information on networks.

And if all that weren't enough, I have the new Kyocera Ecosys laser printer that should run for years without a cartridge change—we'll see—and a new Mac PowerBook.

Stay tuned. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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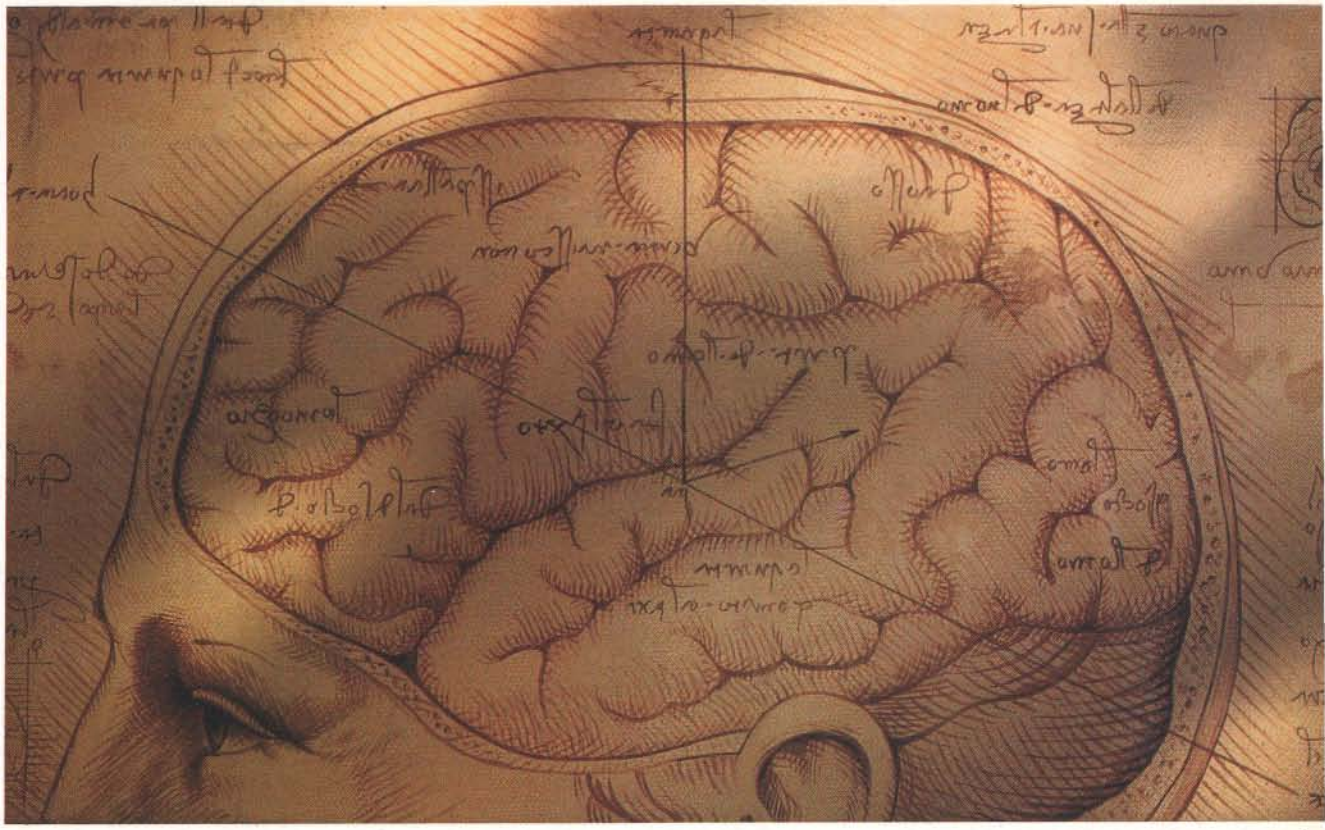

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FEATURE

Make the Right CPU Move

CPU competition has brought confusion along with lower system prices for PC buyers

ANDY REDFERN

A dizzying array of CPU choices awaits the prospective buyer of a DOS-based PC. Four companies—Intel, AMD, Cyrix, and IBM—offer at least 14 varieties of 386- and 486-class processors with clock speeds ranging from 16 to 66 MHz. Intel alone offers over 100 varieties of 80x86 CPUs, with plans for 25 versions of the 486 range in 1993. And don't forget the pending introduction of the Intel P5 chip and promised new 80x86 clones from other vendors early next year.

You can't even make your selection based simply on price and performance any more. Power consumption, math-processing capability, and level of integration all weigh heavily on how well a CPU handles your important applications. Who can blame the PC buyer for being confused?

The people who are most confused are the individual and small-business users, says Paul Nikolas, a salesperson at Fry's Electronics (Palo Alto, CA). "Is a 386/40 faster than a 486SX/20? Even I have trouble with that." Users are especially confused by the differences between SX- and DX-class chips, he says. "I don't even try to explain it all to them. I just try to fit them with the best system I can to meet their needs."

The proliferation of CPUs is partly a product of more vendors jockeying for market position, but most of the diversification serves true user needs. For example, Intel's new low-power 486SL is targeted primarily at notebook PCs, where long battery life and high performance had previously been mutually exclusive concepts. Cyrix's upcoming DRu^2 processor will be sold as a drop-in 486SX-class upgrade product for users of Intel 386DX machines.

To make the best system choice, you need to know the inherent strengths and weaknesses of the available and announced processors. You also need to know relative prices versus performance as well as which CPUs provide the best upgrade paths.

Fortunately, compatibility is not an issue. BYTE has interviewed numerous sources and, in conjunction with the NSTL (National Software Testing Laboratory), has conducted a suite of tests on chips from Intel, AMD, and Cyrix (see the text box "Lab Tests: Does Brand Matter?" on page 116). No one reported any compatibility problems, and the BYTE Lab found none. AMD is "100 percent compatible" with Intel, says Ronald Chwang, president and chief operating officer of Acer America.

continued

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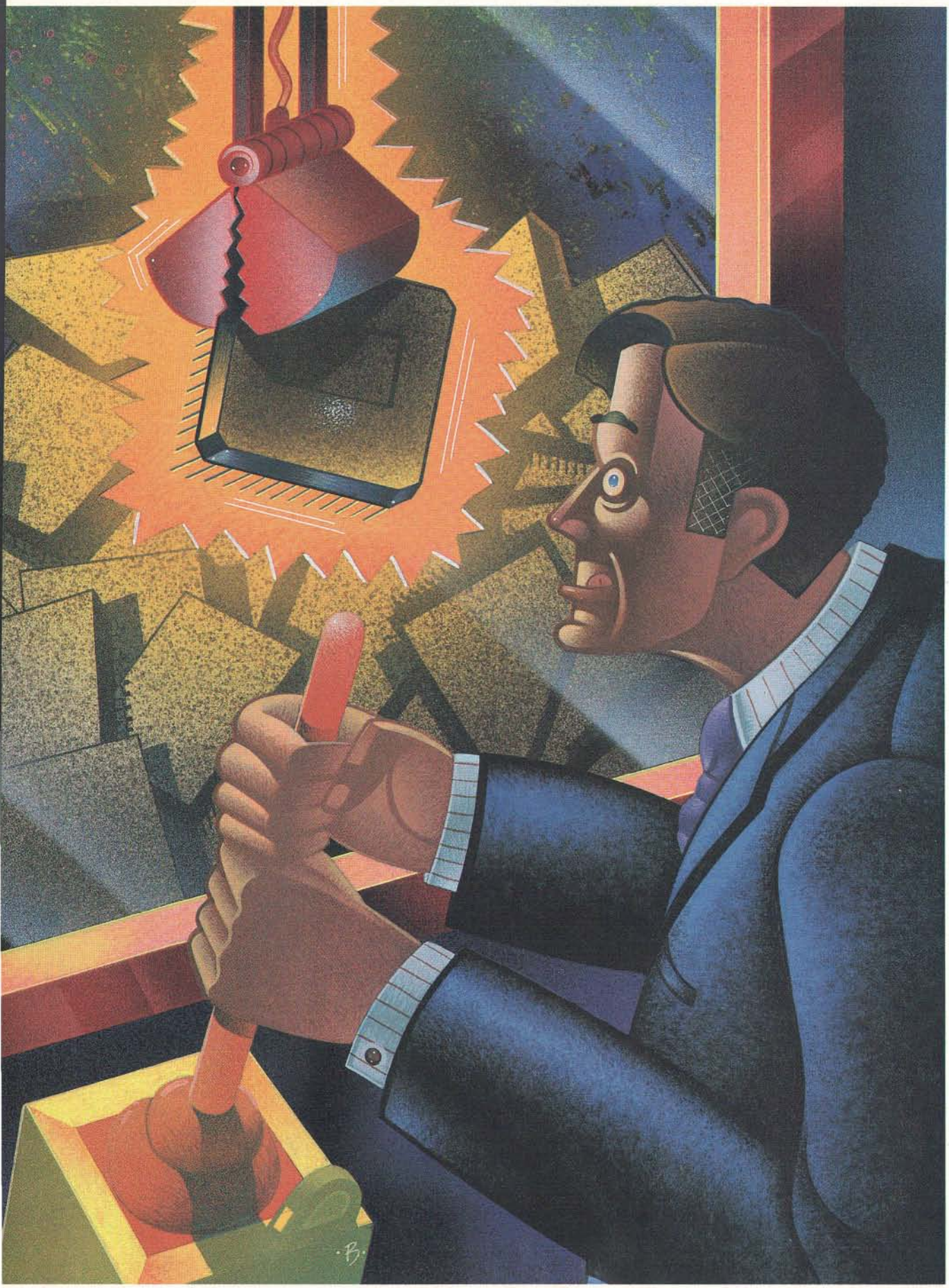

Lab Tests: Does Brand Matter?

RAYMOND GA CÔTÉ

While the amount and variety of processor choices may be bewildering, the real question is whether or not you should be concerned about which chip—Intel, AMD, or Cyrix—is at the heart of your new computer. The BYTE Lab and NSTL (National Software Testing Laboratory—like BYTE, a McGraw-Hill company) explored two likely areas of differentiation: speed and compatibility. We also interviewed a number of people who are knowledgeable about the behavior of the popular CPUs.

We ran our tests on a Tandon PC386 system, which provides a set of daughtercards that use four key processors: a 33-MHz Intel 486DX, an AMD 25-MHz 386SXL and 40-MHz 386DXL, and a 25-MHz Cyrix 486SLC. Our evaluation shows that the core processor is not the only factor to consider. The 25-MHz Cyrix part performed appreciably better than the Am386SXL of the identical speed (see figure A). This is not surprising, considering that the Cyrix has an on-chip processor cache. The processor cache, however, has little effect on non-CPU-bound operations such as database operations.

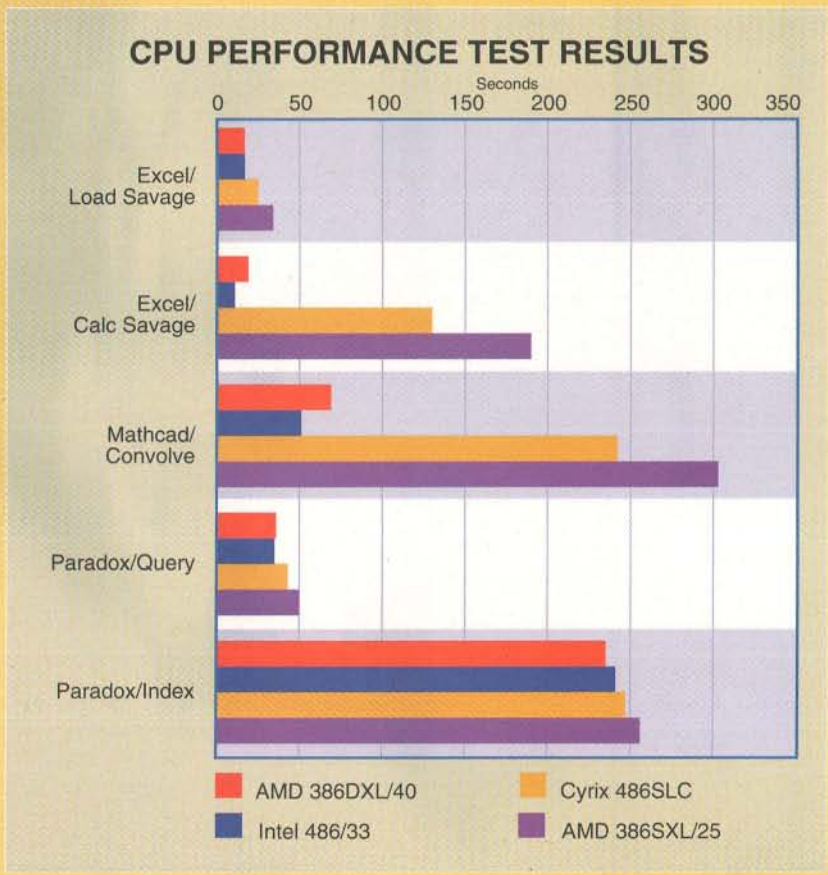

Figure A: *As expected, the Intel 486/33 is faster for most operations. AMD's faster clock speed gives it an advantage in other areas.*

In another test, we evaluated Cyrix's claim to perform integer multiplications four times quicker than competing processors. We ran a test that performed a tight loop with a series of 16-bit multiplies. The Cyrix claim holds true: The integer-multiply function yields a throughput improvement of approximately 400 percent (see figure B).

Our multiplication tests also demonstrated the fragility of speed-improvement claims based solely on small code tests. While developing our test code, we received widely varying results based on the position of the test code in our executable file. Test results varied by as much as 50 percent. This was due solely to whether or not the test code ran entirely from within the processor cache. Cache also comes into play when comparing the 40-MHz Am386DXL with the 33-MHz i486DX, since the Am386DXL had 32 KB of external cache on the daughtercard.

Anything You Can Do...

To achieve compatibility, AMD uses Intel's microcode. Cyrix claims a from-the-ground-up implementation of the 80x86 processor, which it has tested at the signal level to determine full compliance with Intel requirements.

Companies such as BIOS vendor Award (Los Gatos, CA) say that they have not needed to change a single line of their code due to incompatibility with non-Intel chips. Any difficulty in

For John Patterson, Tandy's senior vice president of R&D, "compatibility is an absolute." Tandy is confident enough about Cyrix's 486SLC to use it in its 3800 HD notebook PC. The most serious problem our lab tests found was the failure of some older software to properly recognize the newer CPUs.

Driving Forces

Competition has accelerated the rate of CPU development. When Intel had the 80x86 market to itself, it could afford longer development cycles. Now, AMD and Cyrix are producing processors that either compete with existing Intel units or offer greater

identifying the Cyrix chip is solved by a special identification register on the Cyrix parts. Jeffrey Flink, an Award engineer, says that the diversity of chip sets, the "glue" chips that connect the processors to the rest of the computer, present a greater design challenge.

Likewise, several ICE (in-circuit emulator) vendors did not identify any specific compatibility problems with the AMD or Cyrix processors. Successfully running an ICE provides a level of confidence in the chip's compatibility at the pin level. Although compatibility is not a problem, nobody yet supports the special functions (such as power management and internal cache) available on the Cyrix chips.

We sanctioned NSTL to run compatibility tests against the four Tandon processor modules. Rather than use application software, we based our tests on utility software, which is more likely to delve into less-traveled paths in the processor. Most products ran with no problem, but there were a few surprises.

The first discrepancy had to do with software that tries to identify the type of processor it is running on. For the Cyrix chip, three chip-identification programs found different processors. Norton's SysInfo thought it was a 28-MHz Intel 486DX; PCTools SI found a 25.5-MHz Intel 486SX; and Control Room saw a 50-MHz 386. This highlights the problem of identifying new processors with old software and should warn software developers to stay away from code that is processor-speed dependent.

A more serious problem was exhibited by CPBackup, part of the PCTools 7.1 package from Central Point Software. Before performing a backup, CPBackup does a DMA confidence test. This test hangs the computer when run on a minimally configured system (i.e., no device drivers loaded). According to Central Point engineers, the problem is caused by a software timing loop in their code. (Central Point says it has addressed the problem in an upcoming release by removing the processor-dependent software timing loop.) Although not strictly a compatibility problem in terms of whether or not particular instructions operate properly, it does point out problems that can be encountered when processor configurations are altered. To demonstrate the sensitivity of the problem, running any memory manager, such as QEMM, causes the problem to disappear.

The last problem we uncovered indicates there is as much concern with the complete system interaction as with the individual processor. This problem appeared while running Nu Mega's SoftIce (a low-level debugger) with the Am386DXL/40 processor module. Tracing through a sample program that calls the BIOS Event Wait function (INT 15h, function 83h) causes an internal stack overflow and halts the system. Running this same program at full speed from within SoftIce does not exhibit the problem. At this time, we have been unable to isolate the cause of this problem. Nu Mega and Tandon engineers attempted unsuccessfully to duplicate the problem on other systems using the Am386DXL/40.

We believe these processors are compatible with the Intel standard. Speed and performance are as dependent on the total system environment as they are on the processor itself. It is no surprise that a 40-MHz processor is quicker than a 33-MHz processor, but adding extra external support hardware can balance the comparison. In the final analysis, purchasing your system from a reputable manufacturer is the best way to ensure complete compatibility.

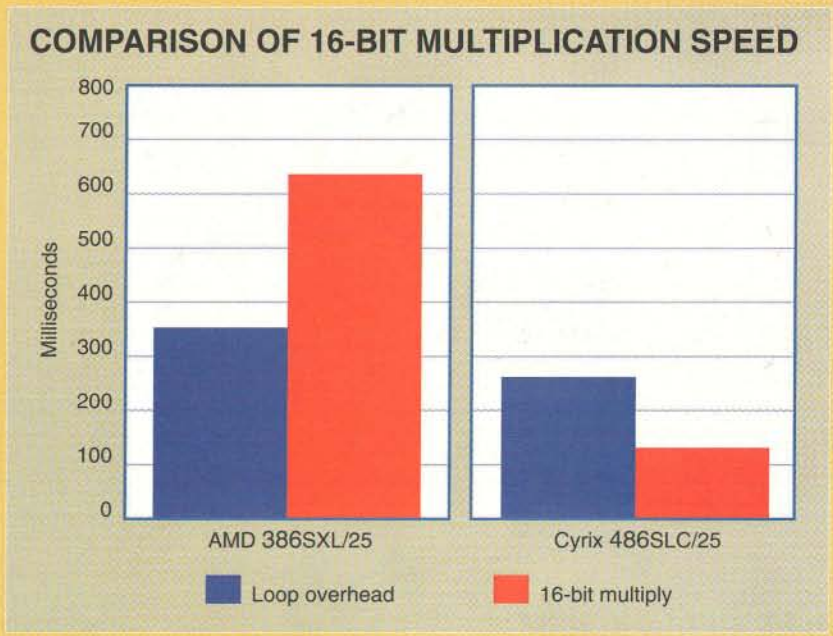

Figure B: *Verification of Cyrix's improvement in the 16-bit integer multiplier. Although the raw numbers show a greater-than-four-times speed improvement, some of the increase comes from executing within the on-chip cache. Taking the speed improvement introduced by the cache into consideration reduces the improvement to slightly less than the claimed fourfold increase.*

Raymond GA Côté is a BYTE Lab testing editor who has worked in industry designing interpretive languages and user interfaces. You can reach him on BIX as "rgacote" or on the Internet as rgacote@bytepb.byte.com.

performance or functionality, usually at a lower price. "Intel has been under a lot more pressure," says Michael Slater, editor and publisher of the influential trade journal *Microprocessor Report*.

IBM, too, produces enhanced versions of the 386SX and 486SX CPUs using its licensing agreement with Intel. Under the agreement, IBM may use its production for its own systems or sell motherboards that use the chips.

This competition has created a buyer's market for makers of PC systems and has contributed to lower system prices. A U.S.-based motherboard manufacturer says that competition from

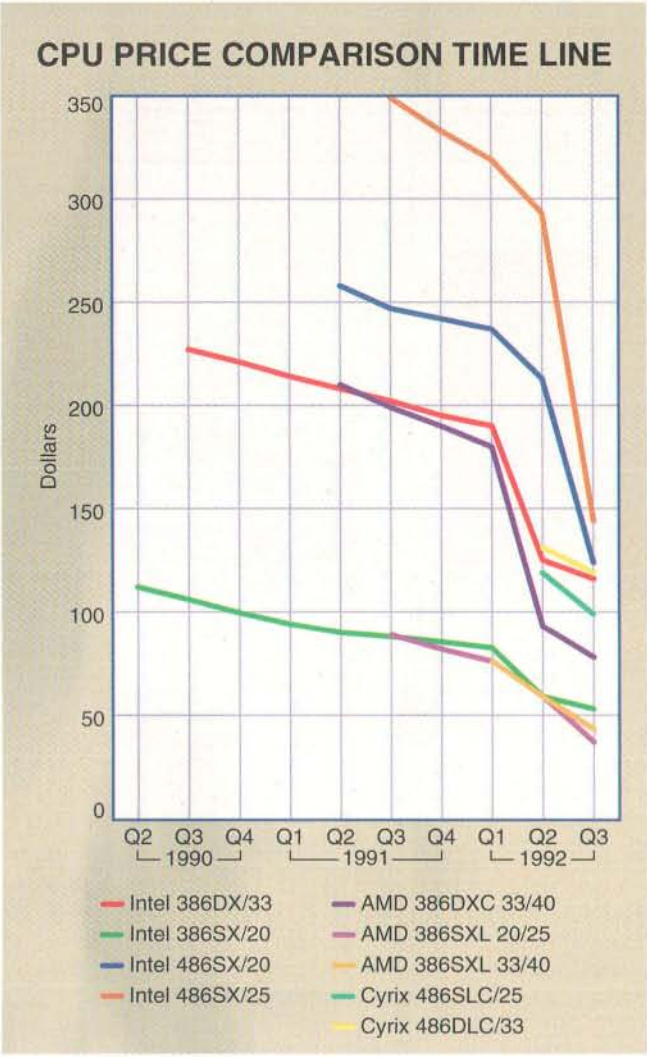

Figure 1: *This chart reveals the full impact of competition that compatible-chip makers like AMD have brought to the CPU market. Since AMD entered the picture in March 1991, Intel has reduced the price of the 33-MHz 386DX chip from $208 to $107. All Cyrix prices include a separate math coprocessor. All prices are cost per unit in lots of 1000.*

AMD has forced Intel to "throw away" the 386-family price list. Figure 1 shows the impact of competition on Intel's CPU pricing. Intel's price for the 16-MHz 386DX dropped about 20 percent from the third quarter of 1988 to the second quarter of 1991, when AMD introduced its 386DXL. From the time of AMD's introduction to today, Intel has dropped the 386DX price by about 43 percent in less than a third of the time.

Designing a state-of-the-art CPU is no simple task. Cyrix spent $10 million bringing its 486SLC and 486DLC to market, a piddling amount compared to the $250 million Intel spent developing its 486. The size of the microprocessor market, however, is seductive. The market research firm Dataquest (San Jose, CA) estimates that the total CPU market (including non-80x86 chips) for 1990 to 1991 was almost $4 billion, with 70 percent belonging to Intel and AMD, representing almost all 80x86 sales in that year. The pie is big enough for new products in both the large and small niches, as AMD has discovered.

AMD introduced the first clone of the Intel 386 chip after a long legal battle with Intel. The court ruled that AMD had the right to sell its CPU because of a licensing agreement with Intel signed during the heyday of the 286. Since then, AMD has been very successful in the 386 market; the company expects to sell over 2 million 386-class CPUs in the last quarter of this year, for what it claims is nearly a 50 percent market share.

AMD has shown a system running a 50-MHz 486DX-class chip, but the chip uses copyrighted Intel microcode. Company president Jerry Sanders says that by early 1993, AMD will bring the CPU to market either by winning the right to do so in court or by writing new microcode.

The diversification of PC systems has created opportunity for new CPU designs; the one-CPU-fits-all approach of the past has been replaced by processors designed for specific form factors. Energy-saving SL-class 386 and 486 CPUs are used almost exclusively in battery-powered portable systems. Low-cost SX-class processors have become the chip of choice for entry-level desktop systems. The high-performance 486DX class powers high-end workstations and servers. And now, highly integrated 8086 and 286-class CPUs are becoming popular for the emerging hand-held category (see the text box "Other Players Find Niches" on page 119).

BYTE spoke to 20 leading PC vendors from around the world. Of those, only 25 percent said they were in the Intel-only camp. Some of those vendors have announced, but not yet shipped, non-Intel systems. Others, such as Dell, plan to stick with Intel exclusively. "The Intel chips offer the performance that we want and the prices that we want to pay," says Dean Kline, public relations manager for Dell.

What's in a Name?

Chip vendors are doing little to help users make direct comparisons. In fact, their marketing departments seem to be deliberately adding to the confusion. For example, Cyrix calls its chips the 486SLC and the 486DLC. However, the chips have no math coprocessor, and they have a different pin-out and a much smaller cache than the Intel 486. They do, however, support the 486 instruction set, and the Cyrix chips perform integer multiplications four times faster than 386-class CPUs.

PC vendors know the difference, but users may not. The Cyrix CPUs are "much higher performance 386s," says Acer's Chwang. He says that the 486SLC performs around 20 percent to 30 percent slower than the Intel 486SX, and recent tests performed in the BYTE Lab on 486SLC systems support his claim.

Bill Berkman, director of product marketing at Mylex (Fremont, CA), a system-board vendor, claims that Cyrix's price is not competitive with Intel's or AMD's 386 pricing—a 40-MHz Cx486DLC costs twice as much as a 40-MHz Am386DXL (although Cyrix includes a separate math coprocessor). He says users would rather spend an extra $100 for a true 486 machine.

Still, companies such as Tandy, Tandon, CompuAdd, and U.K.-based Opus use the Cyrix processors. "Cyrix is a new adventure for us," says Tandy's Patterson, referring to potential customer

Reasons to Upgrade

- Higher performance
- Money saved over new system
- Less downtime during change
- Greater ease in getting purchase approval
- Greater ease in keeping equipment up to date

Other Players Find Niches

ANDY REDFERN, DAVE ANDREWS, ANDY REINHARDT, AND TOM HALFHILL

A host of CPU manufacturers have revealed plans to produce Intel-compatible processors for more specialized applications. These companies include NEC Technologies, Chips & Technologies, International Meta Systems, Vadem, and NexGen.

The earliest player in the Intel-compatible market was NEC, with its V range of processors, launched in 1984. The original CPUs were of Intel design, and NEC was a licensed second source. NEC then supplemented the range with chips of its own design. NEC now sells 30 versions of the V range, including the VHL lower-power, 3.3-volt CPUs. Its processors turn up in machines as diverse as Olivetti's Quaderno Sub-Notebook and Compaq's IDA drive controller. The latest processor is the V55—an 80186-compatible processor running at 12.5 MHz. The original microcode used in the 8086 and 80186 has been implemented in hardware so that the majority of the instructions execute in one clock cycle.

International Meta Systems (Fur, CA) has more ambitious plans. IMS claims it has a new 100-MHz RISC microprocessor, scheduled for mid-1993 production, that can emulate an Intel 486 or a Motorola 68040 at their full native speeds—and at a fraction of their cost. IMS is pitching the CPU for pen computers that need high performance for such tasks as handwriting recognition, but it also says the chip could be used to make a "chameleon computer" that runs both PC and Macintosh software.

In April, the small San Jose–based chip-set designer Vadem introduced a single-chip, palmtop PC-on-a-chip design. Computer manufacturers can use the VG-230 Sub-Notebook Engine to bring small, inexpensive palmtops to market quickly. Vadem's chip design incorporates a 16-MHz NEC V30HL microprocessor into a single-chip device that holds an LCD controller, an internal keyboard scanner, and a built-in power management unit. A PCMCIA 2.0 module provides peripheral support. The latest version of the chip now supports digital ink—a facility aimed at pen-based systems designers. A secondary area of display memory contains an ink trail of where the pen has been moved, allowing the system to process for gesture and handwriting recognition without affecting the original image.

C&T is also turning its attention to the hand-held market. In August, it announced that it will concentrate on integrated processor and logic chips that will allow PC vendors to buy a single-chip solution for their hand-held and notebook products. C&T already has the PC/Chip integrated processor that adds PC functionality to a high-speed 8086 core. It will now develop a 386 core for the PC/Chip and a VGA controller to replace the PC/Chip's low-resolution CGA display driver. Gordon Campbell, CEO of C&T, claims that the first significant systems that offer 50 hours of battery life from four to six AA-size batteries will appear before the end of this year.

The Strange Case of NexGen

Vapor is as common in Silicon Valley as morning fog is in San Francisco. Yet even in an industry where the horizon is frequently clouded by unreleased products, NexGen Microsystems of San Jose, CA, is an enigma.

Founded in 1986, NexGen began work on a 386-compatible microprocessor. Six years later, the company has yet to market a finished chip. In 1990, NexGen seemed to be on the verge of something when it announced a chip set that used CISC architecture to achieve RISC-like performance while emulating 386/486 instructions. Computers based on this chip set would run twice as fast as a 486, SPARC, or Mips system and would approach an IBM RISC System/6000, promised NexGen. Most recently, NexGen said it will have a P5-compatible chip within a month or so after Intel introduces its next-generation microprocessor in early 1993.

This time, some observers think that where there's smoke, there could be fire. Industry analysts speculate that NexGen could take the 486 core it has apparently developed, add parallel integer units, expand the cache, crank up the clock speed, and sell the chip as a "P5 compatible" by mid-1993.

"They don't have a P5 chip," says Michael Slater of *Microprocessor Report*. "What they have is a fast implementation of the 486 instruction set that approaches P5-like performance."

Ken Lowe, an analyst at the market research firm Dataquest (San Jose, CA), agrees: "NexGen is trying to do with its P5-compatible product what Cyrix has done with its 486-compatible product. They're comparing themselves to the P5 because they're trying to achieve P5-level performance. It's a reasonable marketing ploy." Whatever NexGen has under wraps, it may be the company's last chance to prove itself.

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acceptance. Tandy chose the Cx486SLC because it met the company's requirements for performance and price.

Intel believes that users have a hard time distinguishing among the different CPUs, and it has developed a performance rating system that it claims will clarify the issue: iComp (Intel Comparative Microprocessor Performance), a benchmark suite that provides a single index rating for overall CPU performance. The baseline CPU, a 25-MHz 486SX, has a rating of 100. Intel intends iComp to be a quick-and-dirty means of ranking only its own CPUs, although it could be used for any Intel-compatible processor.

System naming conventions confuse the issue, too. A product name that includes *486* (or just *4*) or no clear indication that a

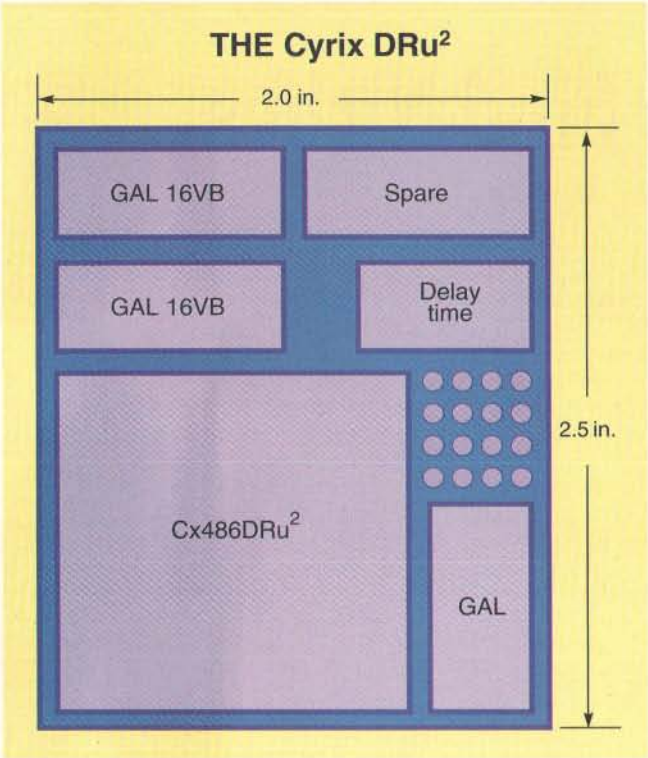


Figure 2: *Cyrix's DRu² is a drop-in replacement for the Intel 386DX/20. BYTE Lab tests indicate that the overall performance boost could be as much as 28 percent. The main CPU is the large square in the lower left; the other items on the 2- by 2½-inch board are support chips.*

Cyrix chip is used is misleading. CompuAdd, for example, has a range of Intel and Cyrix machines including the 425SLC, 425SX, 433i, and 433DLC. Knowledgeable buyers will spot that two of those machines carry Cyrix processors; the average mail-order customer may not be aware of the differences.

Gordon Curran, European vice president of Eurocorp, a European-based market research company, says, "It has been known for some companies to sell machines with AMD 386 processors inside with 'Intel Inside' stickers on the outside." The moral is: Confirm which CPU is used before you buy.

Naming could be a problem for Intel in the future because the U.S. Patent and Trademark Office does not consider three numbers (e.g., 586) to be a legitimate trademark. There is nothing to stop other chip vendors from calling their CPUs *586* to deliberately create confusion.

Upgrade Considerations

The major issues to consider when selecting a CPU are upgradability, performance, and price. Finding the right combination of benefits is tied tightly to the system form factor. The ability to upgrade, for example, is most important to desktop users, although OverDrive sockets—used on Intel 486SX–based systems as a means of installing a 486DX-class CPU—are beginning to appear on portable systems.

Upgrading allows your older system to keep pace with the performance advances in CPUs so you needn't replace the entire box. For a few hundred dollars, you can turn, say, a 16-MHz 486SX PC into a 50-MHz 486DX2 (see "Reasons to Upgrade" on page 118). Few people have actually upgraded their systems. Eric Clow, an analyst at Infocorp, says that the market has not yet completed a cycle. In other words, buyers of upgradable models have not owned them long enough to feel that they are grossly lacking in performance compared to the processing power of state-of-the-art models.

Intel pioneered the concept of a single-chip upgrade with its OverDrive processor, which doubles the internal clock speed of a processor and increases its overall performance by about 50 percent. Prior to the OverDrive chip, most upgrades were accomplished either by replacing the motherboard or by installing an add-in card or daughterboard. "People just didn't want to spend $2000 more for an AST Premium [which was upgradable via an add-in card] knowing that it's upgradable, when they could buy a new motherboard for another $1500," says Doreen Rubin, a Chemical Bank senior report analyst and a member of the Microcomputer Managers Association. But with the doubler chip, upgradability has become a vital issue. Says Rubin, "Until the doubler technology, [upgrading] wasn't something we could sell to the users."

Intel's competitors are just now entering the upgrade market. Cyrix has recently announced a version of its 486DLC chip, the DRu², that can be used to upgrade IBM and Compaq 386DX/20 systems in the field (see figure 2). You simply remove the 386DX chip and drop in the DRu². Cyrix says that the DRu² will work with other 386DX systems, although mechanical considerations—it is about twice as high as an Intel 386DX—might prevent it from fitting in some PCs. Facilities in the 486 DLC that require hardware support, such as the cache and power management, will not work optimally, but the performance increase will still be significant. The most important element of the speed improvement will be Cyrix's clock-doubling technology, which will allow a chip clocked at 20 MHz to run internally at 40 MHz.

BYTE tested a prototype 33-MHz version of the DRu² in an IBM PS/2 Model 80. Overall, it showed a 28 percent improvement over the 16-MHz Intel 386DX in our processor benchmark tests. Low-level video benchmark improvements varied from a minimal 5 percent for scrolling to an impressive 59 percent for graphics. Overall, the video benchmark improved 35 percent. As expected, the low-level disk tests displayed the smallest improvement—only 10 percent overall. Although files were read up to 22 percent quicker, a general throughput test requiring random reads and writes showed only a 1 percent improvement, since it is bound to the speed of the drive, not the processor.

For the time being, Cyrix will sell the chip directly to large customers; no retail is planned yet. Cyrix estimates that the DRu² will be priced between $200 and $300.

There is some skepticism in the industry as to just how many users will upgrade. Jim Chapman, vice president of marketing for Cyrix, says that if only 1 percent of the 30 million 386DX-based machines get upgraded, it will be a major market for Cyrix to support. AMD also sees upgrades as a lucrative market. It has publicly stated that it will support the OverDrive socket that many 486SX machines now include.

Need for Speed

The performance differences among the 386- and 486-class chips are also confusing. AMD keeps one step ahead of Intel's 386SX and 386DX lines by launching faster versions of its 386SXL and 386DXL processors before Intel does.

Cyrix claims performance improvement using an arithmetic unit to perform integer multiplication. Daniel Oulette, vice president of engineering at pen systems vendor Microslate, says he benchmarked the Cyrix 486SLC as 1.8 to 1.9 times faster than the Intel 386SX running at identical clock speeds. But with application tests, the performance was even more noticeable. Microslate's

pen-based systems are popular among users of geographic information systems. "We were seeing four to five times' increase in redraw speeds," Oulette says.

By the time you read this, Cyrix is planning to have introduced a new version of its popular Cx486 chips, the Cx486S2/50. Unlike the 486SLC and 486DLC, the clock-doubled 50-MHz Cx486S2/50 fits into a 486 socket. Since there is no math coprocessor on the chip, it is being called a 486SX equivalent.

Cyrix claims improved performance for the Cx486S2/50 by using a write-back cache, which produces higher throughput with a smaller cache. The Cx486S2/50 will use a 2-KB cache, which Cyrix says is equivalent to Intel's 8-KB write-through cache. A write-through cache operates at the speed of the cache only on read operations. When the processor writes to memory, it has to wait until the result has been written through to the much slower main memory. A write-back cache writes changes back to the cache memory until a cached block goes out of scope. At that point, the whole of the memory block is copied into main memory in fast block-move operation. On an average piece of 80x86 code, this represents a significant speed-up. Cyrix claims average application performance equivalent to a 50-MHz Intel 486DX2; graphics performance shows about a 10 percent improvement.

Cyrix's chip will also be able to access memory in one clock cycle instead of two. It will use a superset of the 486SX instruction set and Cyrix's fast integer-multiply capability. Cyrix expects the price of the Cx486S2/50 to be in the $250 range for OEM customers.

Long used in minicomputer and mainframe environments, instruction profiling has arrived in microprocessors. *Instruction profiling* is the analysis of the relative frequency of instructions used by a suite of applications. With this information, engineers can tune an architecture to execute frequently used instructions in fewer cycles, even at the expense of using more cycles to execute less frequently used instructions, resulting in significant performance gains.

continued

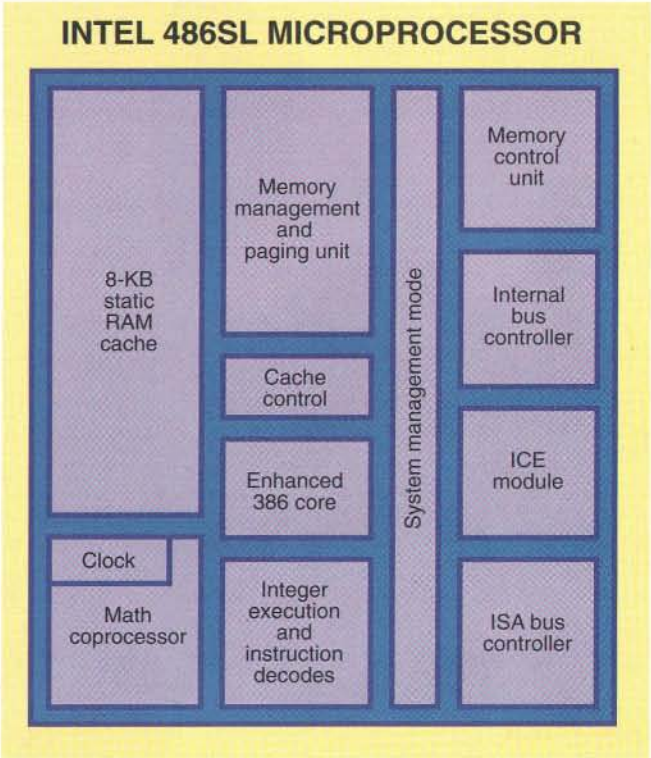


Figure 3: *The 486SL is Intel's 3.3-V CPU intended for notebook systems. It offers not only greater speed than the 386SL but longer battery life, as well. Since it can also operate at 5 V, systems designers can incorporate the 486SL into existing 386SL designs with a minimum of trouble.*

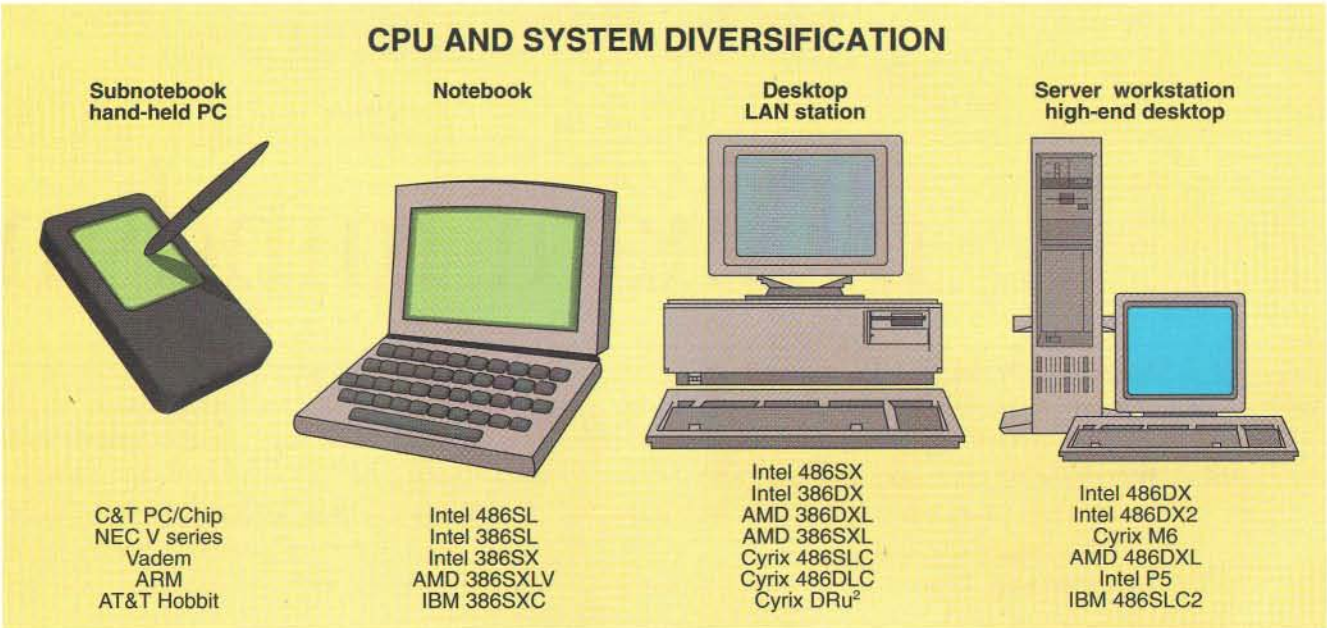
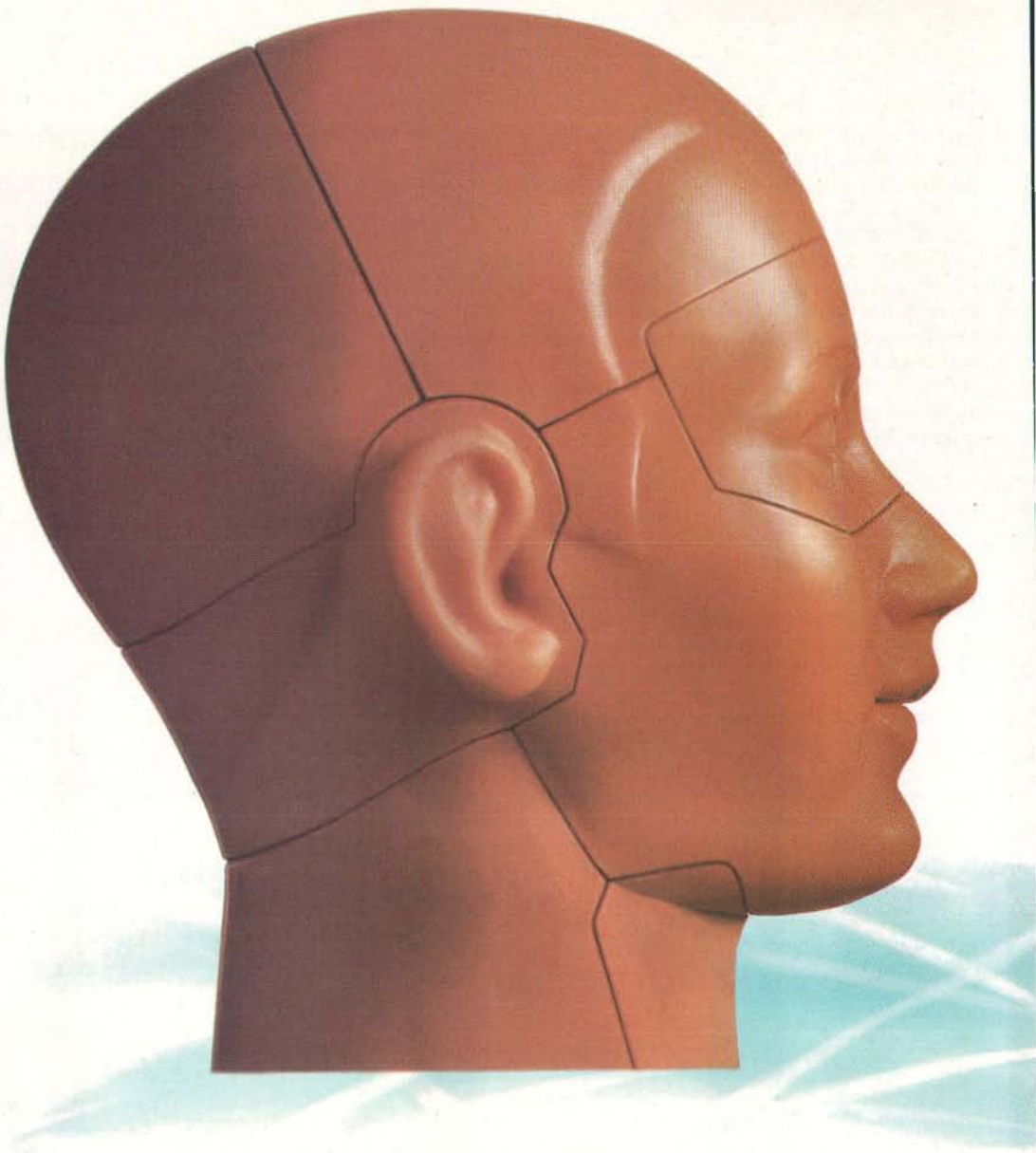


Figure 4: *CPUs are increasingly being designed for the specific demands of each system category. Hand-held computers and subnotebooks require a high level of integration and very low power consumption. Portable systems need both performance and power conservation. Desktop PCs need cost-effective performance. And at the top end, workstations and servers need raw computing power.*



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New Chips on the Horizon

In the next six months, you can expect to see these new processors from the major players in the Intel-compatible CPU market. Since CPU vendors work with systems manufacturers well in advance of their new product announcements, systems using these chips will likely follow soon after.

Intel 486SX/33
The 486SX/33 is simply a faster version of the existing line. Introduced in September.

IBM 486SLC
IBM version of the Intel 486SL. Introduced in October.

Cyrix 33-MHz 486SLC
A faster version of the SLC with a whole new set of power management features. Intended to compete directly with Intel's SL. Introduced in October.

Intel 486SL
The 486SL delivers low power consumption with SX performance. Many notebook vendors have already committed to using it. Available in November.

Cyrix DRu²
A 486DLC that doubles the performance of 20-MHz 386DX systems. Intended to be a user-upgrade product. Available in November.

Cyrix 486S2/50
A 486SX-compatible processor with a smaller cache than Intel's equivalent. Cyrix claims that making its cache write-back compensates for the smaller size. Available in November.

Intel P5
The still-unnamed chip that displaces the 486 as the top of Intel's product line. Expected to be available in the first quarter of 1993.

AMD 486 range
AMD promises 25-, 33-, and 50-MHz versions of its 486-compatible CPU, although analysts suggest a clock-doubling range may also be available. Could be available by the end of this year or by the middle of 1993, depending on the outcome of legal issues involving the use of Intel microcode.

Chips & Technologies' PC/Chip with 386 core
C&T has pulled out of the discrete processor market, and this new chip will be the first of its products to exploit its huge effort in producing a 386-compatible processor for use in hand-held systems and small notebooks. Expected to be available in 1993.

Intel P24T
The Intel P24T is an upgrade processor for 486DX2 systems. Sockets for the chip are already being designed into some motherboards. The socket is similar to a conventional OverDrive socket but has an extra row of pins. The P24T will use P5-based technology to increase performance. Intel won't say exactly what "P5-based technology" means, but it's possible the P24T will incorporate the P5's improved FPU or parallel integer pipes. Intel plans to introduce this CPU in early 1994.

NexGen's P5 clone
A P5-type chip that NexGen hopes will appear shortly after Intel finally ships the P5. Given NexGen's history, you may have to wait until 1994 before it actually ships.

Intel uses instruction profiling extensively in the design of new processors and is accumulating an enormous database of instruction traces of various commercial applications. One result of Intel's profiling has been the difference in instruction use between applications written in C++ and those written in other languages, which shows the close relationship between compilers and processors. If C++ comes to dominate commercial development environments, Intel and others may find it beneficial to tune their architectures to the instruction frequency of the language.

Performance on Batteries

Performance takes on another dimension in the portable PC arena, where power conservation and a high level of integration are primary concerns. Intel is scheduled to announce its low-power 486SL family by the time you read this. The first two microprocessors are clocked at 25 and 33 MHz, and both have integrated math coprocessors. Intel says that, because the 486SL is physically smaller and more highly integrated than the 386SL, vendors will be able to reduce the size of notebook motherboards by 60 percent. The 25-MHz chip is already in production, and the 33-MHz version is scheduled for the first quarter of 1993.

The 486SL (see figure 3) is a significant improvement over the 386SL. Intel claims that performance ranges from 11 MIPS for the 25-MHz 486SL to 14.5 MIPS for the 33-MHz version. By comparison, the fastest 386SL (25 MHz) is rated at 5.2 MIPS.

Equally important is the 486SL's "flexible voltage" feature. Although the 486SL is a 3.3-volt static device, it can also operate at 5 V. Thanks to this—and to the 486SL's compatibility with the 386SL's SMM (system management module) and companion I/O chip—laptops with the new CPU should be available by the end of the year. While some vendors may simply adapt the 486SL to existing 5-V motherboards, the more advanced machines will operate at 3.3 V. When the 486SL is mated to other 3.3-V parts, power consumption is reduced 50 percent from a 5-V 386SL system. Intel says this should yield 1 to 4 hours of additional battery life.

Like the 386SL, the new 486SL has a PI (Peripheral Interface) bus that's functionally equivalent to a local bus in a desktop computer. The PI bus allows a graphics controller or flash card to bypass the I/O bus and link directly to the CPU. The PI bus operates at the CPU's full clock speed, compared to the relatively slow 8-MHz bandwidth of the I/O bus.

The Price Factor

Competition has reduced chip prices, and initially it reduced system prices. The 25-MHz 486DX originally cost $950 (in quantities

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of 1000) in 1989 and was a significant contributor to the total system price; it now costs $328. According to Steve Warren, vice president of Altima Systems (Concord, CA), a laptop manufacturer, the CPU price now has a much less significant effect on system cost. Altima sells an AMD 386SXL–based system and an Intel 386SL system. Altima's AMD-based system is 10 percent less expensive than its Intel version, but Warren says that the added performance provided by an external cache on the Intel portable compensates for its extra cost.

Intel has one price advantage over its competitors: cooperative advertising. Intel pays system vendors to support the "Intel Inside" campaign, subsidizing part of a vendor's ad cost. This arrangement is particularly attractive to mail-order companies that depend entirely on advertising to generate revenue. Two U.K. manufacturers, Elonex and Viglen, claim that Intel reimburses 5 percent of their total magazine and newspaper advertising costs as long as they use the "Intel Inside" logo on their ads. A U.S.-based manufacturer says it has a similar deal, but Intel pays only 3 percent of its costs. For many vendors, this deal more than makes up for the price differential between Intel and its competitors.

Many users and vendors feel safer with Intel. Marc Vena, a product manager at Epson America (Torrance, CA), says, "If you have two processors—one from AMD and one from Intel—priced the same, we'd go with Intel because of the resources and relationships we formed with them."

This view is echoed by the software developer WordPerfect (Orem, UT). Peter Maughan is in charge of providing the company's staff with networks and network workstations. He tests any machine WordPerfect might purchase. He says, "The machines we have the least problems with have Intel processors."

Function Fits Form

Systems are becoming more diverse (see figure 4). Areas that were once considered to be a niche market have become mainstream. For example, the market share taken by desktop systems has fallen as notebooks have become powerful enough to be considered an acceptable alternative. Predictions by InfoCorp, a market research firm, for growth in the worldwide notebook market reveal that although sales by volume represented just 14.5 percent of the total PC market in 1992, it will rise to 22.7 percent within two years.

Intel has broadened its range of processors to meet the competition from other chip vendors in niche markets, as evidenced by its planned introductions of 25 versions of the 486 CPU in 1993. The range of processors that system vendors will support is large. Processors will get faster and run on lower power. AMD and Cyrix will have full 486-compatible chips, and even Intel's big hope, the P5, looks under threat from NexGen and others. *Microprocessor Report*'s Slater says, "It is inevitable that Intel's share of the microprocessor market, as well as its profit margins, will decline." He would not estimate by how much.

The divergence of technology allows Intel's competitors to succeed with processors that take advantage of emerging niche markets and holes in Intel's product line. AMD, for example, succeeded with its 40-MHz 386DX because it met a demand for a higher-performance 386. Intel is being squeezed out of certain market segments and has yet to get a serious foothold in the hand-held market. Intel has, however, joined forces with VLSI Technology to eventually produce a 386SL-based chip set for hand-held machines.

Intel is even willing to develop chips customized for specific applications. Its RapidCAD coprocessor, launched last February, is a two-chip upgrade that uses both the 386 and 387 sockets. The 386 socket is occupied by a hybrid 386 and 387 combination chip, while the 387 socket is occupied by a custom

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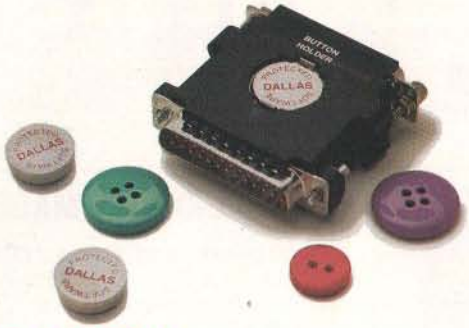

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CPU performing exception handling (e.g., divide-by-zero errors). The chip set works in any 386 machine up to 33 MHz and provides an average performance increase of 20 percent to 30 percent on graphics-intensive applications such as CAD.

The Next Generation

Although Intel does not expect to launch the P5 until early in 1993, many of its design details have been made public. It will use a superscalar architecture, which means that it will have two or more execution units. This will allow the processor to perform a number of instructions in parallel during one clock cycle.

The integer unit makes the five-stage pipeline of the 486 even quicker by running two in parallel. The pipeline decodes two instructions simultaneously, and if they do not conflict, they execute in parallel. This double pipeline could represent a 50 percent speed-up over the previous design. Two other key parts of the integer unit are a branch target buffer and a dual-access data cache. The branch target buffer predicts the outcome of branches; if correct, the branch executes without delay. The dual-access cache handles both data and addresses from the pipes and contains logic for resolving address dependencies.

The P5 math coprocessor has three dedicated arithmetic units and an eight-stage pipeline that's integrated with the integer pipeline but includes two more execution stages. Although the math coprocessor is tuned for double-precision memory-to-register operations (the most common type expected), Intel says the unit handles single-precision and register-to-register operations just as quickly.

The 486 uses 1-micron technology to pack 1.2 million transistors; the P5 uses 0.8-micron separation and has 3 million transistors. Intel says the first version of the P5 will run at 66 MHz and exceed 100 MIPS. Graphics-intensive applications, database servers for client/server systems, and multitasking applications are some of the uses that could make the most of this power.

But Intel isn't the only manufacturer looking beyond the 486 (see the text box "New Chips on the Horizon" on page 125). Subodh Toprani, director of marketing and systems engineering for AMD's personal computer products, says that his company has "significant plans beyond the 486." Toprani notes that AMD is a leading supplier of RISC architecture products. This is important because RISC technology will be a major factor in the next generations of chips. Toprani says the company will offer a "new generation" of chips sometime in 1993 that will "transcend" the current generation.

Cyrix claims that it will offer a P5-compatible chip shortly after Intel introduces its version early next year. Cyrix also claims that it will come out with the next generation of chips, the so-called 686, before Intel. Cyrix says this is possible because its production cycles are shorter than Intel's. *Microprocessor Report*'s Slater says, "Almost everyone has underestimated the difficulty of implementing these superscalar designs. Until Cyrix ships, such statements can be regarded only as unsubstantiated claims."

The multitude of microprocessors has made it difficult to choose a system. But that problem has been more than offset by performance gains and lower system costs brought on by competition among CPU vendors. "Using a computer is becoming so much easier," says Chemical Bank's Rubin. "The more power you give people, the more they're going to use it." ■

BYTE editors Rich Malloy, Gene Smarte, Dave Andrews, Ed Perratore, Patrick Waurzyniak, and Tom Halfhill also contributed to this article.

Andy Redfern is BYTE's U.K./Europe bureau chief based in London. You can reach him on BIX as "aredfern."

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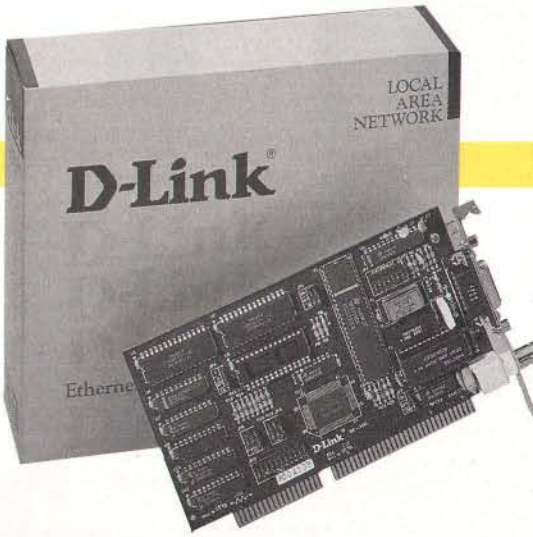

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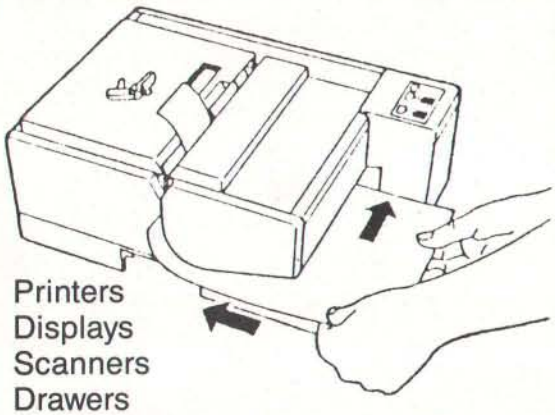

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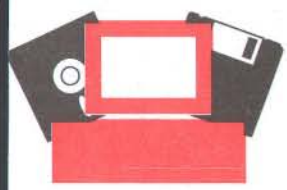

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602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

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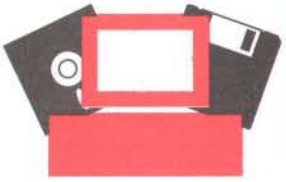

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TrueType A to Z

TrueType helps make typeface technology easier for Windows 3.1 users

GREG LOVERIA

The multitude of available typeface technologies and formats and the way each is implemented into personal computer applications are daunting. For example, Adobe Systems offers over 13,000 typefaces in Type 1 scalable-outline format and Type 3 bit-map format. Before the release of ATM (Adobe Type Manager), you could print Adobe typefaces only on devices that implemented Adobe's own PostScript printer language.

Other typeface offerings use incompatible typeface formats, such as Bitstream's Speedo and Fontware, Hewlett-Packard's Soft Fonts, and Agfa Compugraphic's Intellifont. Also, some typefaces are application-specific and won't function with multiple publishing applications. To that last bit of ultimate confusion, add a sprinkling of inexact type vernacular (see the text box "The Terminology of Type" on page 132).

Fortunately for Windows 3.1 users, Microsoft's inclusion of TrueType's scalable typeface technology may help clear up the confusion. TrueType, developed and released by Apple in May 1991, is now part of Windows 3.1. Apple's goal for TrueType was to simplify font installation and management chores. Another major objective was for TrueType's printed characters to match those on-screen, with screen and printer resolutions being the only slight visual difference.

Comparing PostScript and TrueType

Adobe's PostScript is a complete PDL (page-description language) and excels at printing fonts and graphics. In a Windows environment, ATM lets applications access Type 1 typefaces and instantly produce smooth, antialiased Type 1 screen fonts at any point size, emulating on-screen what the Type 1 printer font will look like when printed. When you modify text by changing a font's point size, ATM instantly scales and builds screen fonts on the fly to the new point size needed. Before ATM, users of Type 1 typefaces had to prebuild screen fonts at multiple point sizes for each typeface in use. ATM also allows dot-matrix and non-PostScript printer owners to print Type 1 typefaces. Bitstream's FaceLift functions much like ATM and uses Bitstream's Speedo and Adobe's Type 1 typeface formats.

By contrast, TrueType uses a separate type management and scaling management program. TrueType has auto-scaling and antialiasing algorithms built into each typeface. TrueType fonts print to any device—including PostScript devices—supported by Windows 3.1's printer drivers. However, TrueType is strictly a typeface display and print solution, not a combined typeface and graphics print solution such as

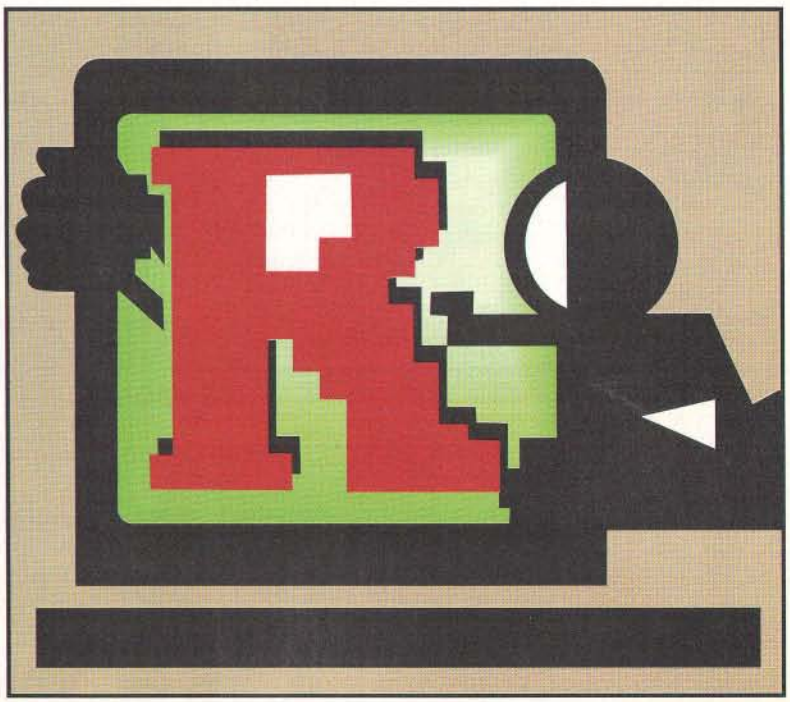
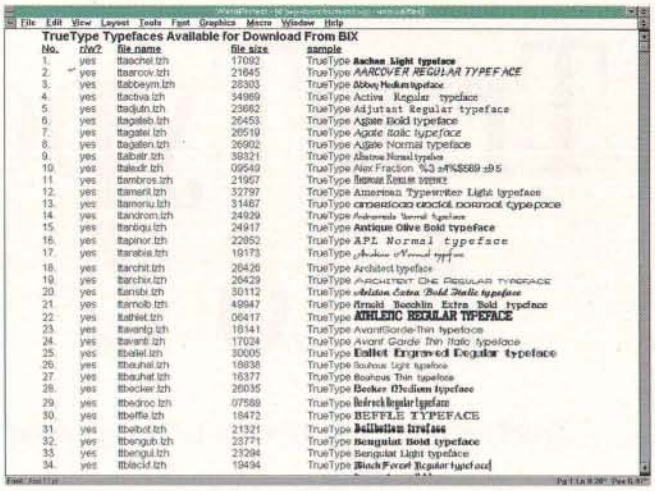


ILLUSTRATION: CHRIS SPOLLEN © 1992

PostScript. TrueType typefaces are not PostScript or Bitstream typefaces; the technologies are not interchangeable.

The Tough Old Days of Type

Generally, only two classes of fonts are built for any given point size from a typeface family: printer fonts and screen fonts. Printer fonts output to printed pages from a laser printer, while screen fonts represent the printer fonts on computer displays. The need for separate printer and screen fonts arose because monitors can display fonts only at resolutions of from 72 to 120 dots per inch on-screen, while standard laser-printer output resolutions range from 300 to 600 dpi. Because of these device-resolution differences, display fonts were needed to visually estimate prior to printing how printer fonts would output from desktop publishing applications.



TrueType Typefaces Available for Download From BIX

No.	rhv?	file name	file size	sample
1.	yes	tfaachel.tzh	17092	TrueType Aachen Light typeface
2.	yes	tfaarcov.tzh	21645	TrueType AARCOVER REGULAR TYPEFACE
3.	yes	tfabbeym.tzh	28303	TrueType Abbey Medium typeface
4.	yes	tfactiva.tzh	34989	TrueType Activa Regular typeface
5.	yes	tfadjutn.tzh	29662	TrueType Adjutant Regular typeface
6.	yes	tfagalsb.tzh	26453	TrueType Agate Bold typeface
7.	yes	tfagalsl.tzh	26519	TrueType Agate Italic typeface
8.	yes	tfagalsn.tzh	26902	TrueType Agate Normal typeface
9.	yes	tfabalt.tzh	38321	TrueType Albatross Normal typeface
10.	yes	tfalexfr.tzh	09549	TrueType Alex Fraction %3 a4%$589 a95
11.	yes	tfambros.tzh	21957	TrueType Ambrose Regular typeface
12.	yes	tfamerit.tzh	32797	TrueType American Typewriter Light typeface
13.	yes	tfamoriu.tzh	31467	TrueType americaco social normal typeface
14.	yes	tfandrom.tzh	24929	TrueType Andromeda Normal typeface
15.	yes	tfantiqu.tzh	24917	TrueType Antique Olive Bold typeface
16.	yes	tfapinor.tzh	22852	TrueType API Normal typeface
17.	yes	tfarabia.tzh	19173	TrueType Arabian Normal typeface
18.	yes	tfarchit.tzh	26426	TrueType Architect typeface
19.	yes	tfarchix.tzh	26429	TrueType ARCHITECT ONE REGULAR TYPEFACE
20.	yes	tfarisbi.tzh	30112	TrueType Arlston Extra Bold Italic typeface
21.	yes	tfarnolb.tzh	49947	TrueType Arnold Boechlin Extra Bold typeface
22.	yes	tfathlet.tzh	06417	TrueType ATHLETIC REGULAR TYPEFACE
23.	yes	tfavantg.tzh	16141	TrueType AvantGarde-Thin typeface
24.	yes	tfavanti.tzh	17024	TrueType Avant Garde Thin Italic typeface
25.	yes	tfbalel.tzh	30005	TrueType Ballet Engraved Regular typeface
26.	yes	tfbauhal.tzh	18838	TrueType Bauhaus Light typeface
27.	yes	tfbauhat.tzh	16377	TrueType Bauhaus Thin typeface
28.	yes	tfbecker.tzh	26035	TrueType Becker Medium typeface
29.	yes	tfbedroc.tzh	07589	TrueType Bedrock Regular typeface
30.	yes	tfbeffle.tzh	18472	TrueType BEFFLE TYPEFACE
31.	yes	tfbelbol.tzh	21321	TrueType Bellbolin Italic
32.	yes	tfbengub.tzh	23771	TrueType Bengulat Bold typeface
33.	yes	tfbengul.tzh	23294	TrueType Bengulat Light typeface
34.	yes	tfbfecid.tzh	19434	TrueType Black Forest Regular typeface

TrueType typefaces from multiple vendors abound, but commercial TrueType suppliers are not the only sources from which Windows 3.1 users can acquire typefaces. This screen capture is a small sample of the 100-plus public domain and shareware TrueType typefaces available for downloading from BIX via modem.

The solution was Windows 3.0, which shipped with a limited set of combined screen and printer typeface families that included Helvetica and Times Roman. Before TrueType and ATM, if typefaces were added, you had to build separate screen fonts from the new typeface, one for each font point size used in a document. For nonoutline bit-mapped typefaces, this required building screen and printer fonts not only for Windows applications but also for DOS programs, such as Ventura Publisher or First Publisher. Because Adobe's PostScript typefaces have always used scalable-outline technology, you haven't had to build printer fonts, but you have had to build screen fonts.

For desktop publishing printing, there are two broad classes of laser printers: PCL (based on HP's Printer Command Language) and Adobe's PostScript. To print fonts, PCL printers required that you first build the soft fonts and then download them to your printer's memory from a hard disk. If the printer was turned off, you would have to download the soft fonts again before starting the next printing session. Building, maintaining, and managing display and printer fonts was time-consuming and rapidly depleted hard disk space.

Another solution was to use a font cartridge that stored typefaces in a hardware cartridge's nonvolatile EPROM. Font cartridges plugged directly into a PCL printer and circumvented the soft-font uploading process, but you still needed to build screen fonts.

PostScript printers use a mathematical outline description of each typeface that can instantly rescale a printer font to any point size. When Apple released its LaserWriter printer in 1984, it included 35 PostScript scalable-outline fonts along with Adobe's PostScript rasterizing algorithms resident in the printer's ROM. Any Macintosh-based application could display these 35 typefaces in almost any font point size because of the Mac's built-in GUI environment. On the PC side, VGA displays were nonexistent. As VGA and higher-resolution displays became a mainstay on the PC platform, Windows users wanted access to the same Type 1 typefaces used on the Mac, so Adobe released ATM for Windows 3.0.

Currently, Windows 3.1 ships with five typeface families: Arial, Courier New, Symbol, Times New Roman, and Wingdings. Except for the above system typefaces, all TrueType typefaces contain screen and printer information—called *hints*—on how to correctly display and print fonts at any point size selected from a TrueType typeface family. Because TrueType typefaces are outline representations, they are instantly rescalable and can function with any Windows 3.1–supported monitor and printer (see the screen). TrueType system typefaces are read/write enabled, so you can embed complete typefaces (not just a font) in a document.

Embedding

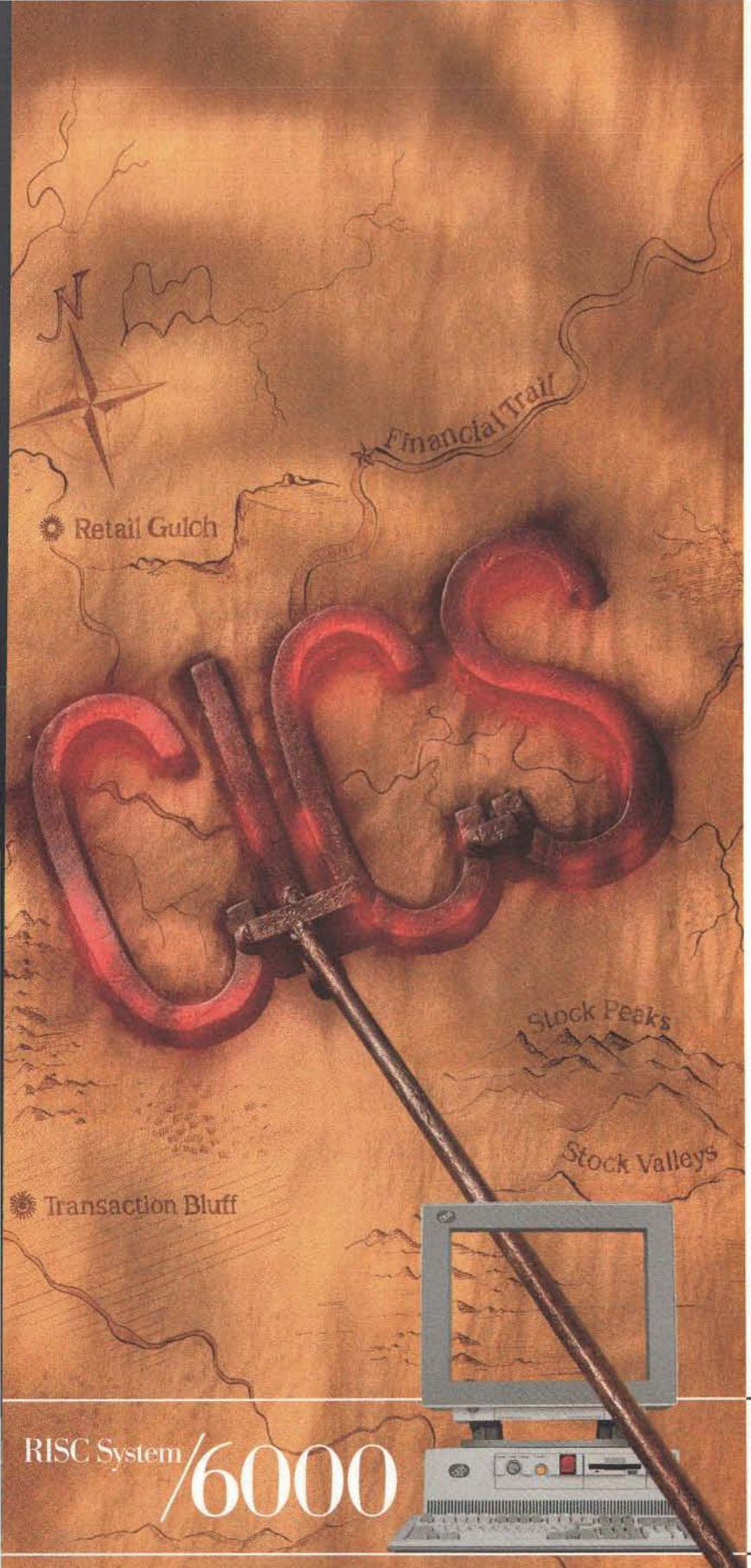
Any TrueType typeface that a type manufacturer designs as read/write enabled can be embedded directly into and shipped along with a document file. Since TrueType typefaces contain both printer and display fonts, any Windows 3.1 user who receives a document with read/write enabled typefaces can view, edit, and print the document exactly as its originator created it. Windows 3.0 users can often display version 3.1 files without difficulty because of Windows' GDI (Graphics Device Interface). If Windows 3.0's GDI cannot find the font in use in a Windows 3.1 document, it displays the nearest corresponding screen font installed in Windows 3.0. However, because a type manufacturer's revenues depend on typeface sales, not all TrueType typefaces are designed with read/write capabilities, which means some typefaces cannot be embedded and distributed.

Fortunately, three restriction levels of embedding protect TrueType typeface manufacturers from copyright infringement and from illegally embedded typeface distribution. At the same time, these restrictions provide Windows 3.1 users with varying degrees of typeface functionality. In the first level of embedding, a manufacturer may design the typeface to be unembeddable, or *protected*. Only applications that have TrueType's typeface embedding feature built into them can include TrueType typefaces with a document file. At this writing, the only application supporting TrueType embedded typefaces is Microsoft's PowerPoint; however, Microsoft and other Windows 3.1 software developers are upgrading applications to support typeface embedding. You should expect to see many of these applications in the near future.

Also in the first level of embedding, you must buy and install the exact TrueType typefaces used in the original document to

Key TrueType Features

- Separate type management program
- Separate scaling management program
- Auto-scaling/antialiasing algorithms for each typeface
- Support for Windows 3.1–compatible printers



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The Terminology of Type

In addition to multiple typeface formats, typesetting terms are often used differently in desktop publishing environments, which creates confusion. Typesetters use the word *font* to specifically describe point sizes, weights, and styles selected from an individual typeface, as in "We used a 12-point Times Roman Italic font in the document." In typesetting terms, Times Roman 12 point and Times Roman 18 point are both fonts, not typefaces. Typeface families are designated into groups such as Times Roman Italic or Times Roman Bold and are part of the same typeface family, but each designation contains complete sets of characters all representative of that typeface's designated stroke, weight, slant, and width.

On the other hand, desktop publishers often interchange the terms *font* and *typeface* to describe whole typeface families, as in "I would like to use Helvetica and Times Roman fonts in the document," when they actually mean they would like to use the Helvetica and Times Roman typeface families in the document. Fonts are built individually at different point sizes selected from a chosen typeface.

correctly display the document you receive. If you already own the proper typefaces, you can also print and edit the document.

In the second level of embedding, manufacturers can design typefaces that have read-only protection. You can view and print the received document, but you cannot edit it. Disabling the editing function restrains end users from deleting text and from using the empty document as a template to create future documents using typefaces included in the original document file.

The third level of embedding lets typeface designers create typefaces that are both read- and write-enabled. You can view, edit, or print documents received with read/write typefaces embedded to meet your requirements.

Applications that support embedding also provide an option that lets you permanently install into Windows the new read/write typefaces embedded in a document. These applications can automatically perform new typeface installations by updating Windows 3.1 typeface lists in the WIN.INI file and then auto-extracting the embedded typeface files (e.g., FONTNAME.FOT and FONTNAME.TTF) to the WINDOWS\SYSTEM subdirectory. There are pros and cons to read/write embedding. Users without extensive hard disk capacity who receive large multifont documents may find themselves out of storage space, because TrueType generally occupies about 70 KB of storage space per typeface (versus about half this amount for Type 1 typefaces).

Take a Hint

Hinting algorithms are calculations that improve the quality of typefaces on both printer and screen output. Without hinting instructions, characters would have random pixels sticking haphazardly out of a character, or crossbars might disappear on *A* or *H* characters. This is due to the relatively small number of dots a 300-dpi printer and a 72- to 120-dpi VGA monitor have. Hints are usually applied to typefaces at sizes below 12-point for 300-dpi printers and 18-point for VGA displays; printer hints are not necessary when the output resolution of a device is above 600 dpi. Hints are designed as integral parts of a TrueType typeface. Adobe's Type 1 typefaces include few hinting instructions and use the PostScript rasterizer in the printer to apply most hinting instructions.

Sampo Kaasila, Type Solution's president and founder, described Adobe's Type 1 hints as declarative: they merely identify certain strokes within a typeface that need hinting, which for the most part leaves hint decisions to Adobe's PostScript rasterizing process. Type Solutions manufactures TypeMan, typeface development software that Microsoft used for applying hints to Windows 3.1's system typefaces, as well as to its TrueType FontPak typefaces. With Adobe's Type 1 typefaces, on-screen, ATM's rasterizer performs the final hinting decisions; in a PostScript printer, the ROM-based rasterizer performs the hinting. On the other hand, TrueType hinting is a procedural process built into every TrueType typeface. This process doesn't just suggest how to apply hints to a font—it gives direct orders.

These direct hinting instructions included in every TrueType typeface are one reason why TrueType typefaces are somewhat larger in file-size bytes than comparable Type 1 typefaces. Having these direct hints applied by the typeface designer certifies that once the designer releases a TrueType typeface, an engineer making hint improvements to a rasterizer cannot change the typeface. Hinting improvements to PostScript typefaces are applied globally via rasterizer updates, as in the case of the upgrade from ATM 1.0 to 2.0. Hints for all 13,000 Type 1 typefaces were modified by the ATM 2.0 rasterizer upgrade. However, future TrueType typeface designer hint improvements on any typeface will require you to purchase a complete new typeface, not just a rasterizer. Using a program such as TypeMan, you could change any singular TrueType typeface's hint instructions.

There is much debate over which hinting procedure will prove most effective for the end user. For users with large collections of Adobe Type 1 typefaces, it's obviously much easier just to apply future Adobe hinting updates globally to every typeface in one procedure. The TrueType camp believes that Windows users will find purchasing singular typefaces that include hint improvements less time-consuming and easier.

At present, most typeface modification and conversion programs apply hints automatically between typeface formats. However, future typeface creation programs will require an understanding of hints and their importance when designing typefaces.

Print Considerations

Using TrueType typefaces, Windows 3.1 examines each document line-by-line at print time. Only specific TrueType characters needed to print documents are downloaded to the printer. After printing, printer memory is cleared for the next print job. For laser printers with more than 2 MB of RAM, setting printer memory options on the Control Panel instructs the Windows 3.1 printer driver in use to retain previously downloaded TrueType characters in printer memory. This alleviates the need for character uploading, which makes printing from Windows even faster in this configuration. Printers with less than 2 MB of RAM cannot retain

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TrueType characters because this base memory is used for printing full-page graphics. As mentioned earlier, TrueType is only a font-scaling and printing technology, while Adobe PostScript is a PDL technology. PostScript uses a rasterization process to convert whole pages, including fonts and graphics, into one large bit-mapped image. There are trade-offs to either technology.

Complete PostScript pages are rasterized bit-mapped images that, depending on your system configuration and available printer memory, can have slower printing times than a similar page using TrueType typefaces on a non-PostScript printer implementing HP's PCL. At one point, while seeking to enhance graphics printing by increasing TrueType print times, Microsoft established a TrueImage group to accomplish these tasks. But Microsoft's engineers developed the character-by-character download process that enhanced print speeds considerably and incorporated it directly into Windows 3.1. The TrueImage technology was subsequently licensed to third-party printer manufacturers, such as LaserMaster and Microtek.

On the other hand, Adobe's claim that "PostScript prints anything" rings true. When you combine graphics with TrueType fonts and then print the document on a PCL printer, you still get a less-than-desired appearance; the text looks great, but the graphics images look only fair. Windows 3.1, however, can convert and print documents using TrueType typefaces and graphics directly to PostScript devices with excellent results. In TrueType, conversion of font outline to PostScript bit map is automatically accomplished within Windows and is controlled by the specific printer device selected in the Windows Printer Control utility.

For Windows users with PCL or dot-matrix printers, one solution to PCL/PostScript print differences may be Zenographics' SuperPrint, a $149 software package. SuperPrint installs its LaserJet SuperDriver into the Windows Control Panel, and when selected, it lets you print both graphics and text up to PostScript quality on PCL or dot-matrix printers. Even if you have only a nine-pin dot-matrix printer, the characteristic dot-matrix banding virtually disappears. In PCL print tests on a LaserJet IIP, SuperPrint rivaled PostScript graphics and text output.

Coexisting Peacefully

With the success of Windows 3.1, many of the old digital type manufacturing professionals, such as Agfa and Bitstream, are rapidly converting original typeface families from proprietary and Type 1 formats to TrueType formats. It is improbable that TrueType typefaces will outpace Adobe's and other manufacturers' sizable leads in the digital typeface marketplace in the near future. In addition, you will soon be able to modify a typeface without external programs by using Adobe's Multiple Master and TrueType GX typefaces.

With Windows applications moving rapidly into MPC and nonlinear video editing, typeface manufacturers will find new markets, as these applications will use typefaces for character generation and video titling. Just as multiple typeface vendors have survived using unique technologies in past markets, you can expect TrueType to coexist with other typeface formats. One thing is certain: TrueType has heightened the personal computer user's typeface awareness, and most users will never look at digital type in the same light again. ■

ACKNOWLEDGMENT

Steve Puntolillo, a Zenographics typeface and print specialist, contributed technical information for this article.

Greg Loveria is a computer graphics and desktop publishing consultant, animator, and writer in Binghamton, New York. He can be reached on BIX as "loveria."

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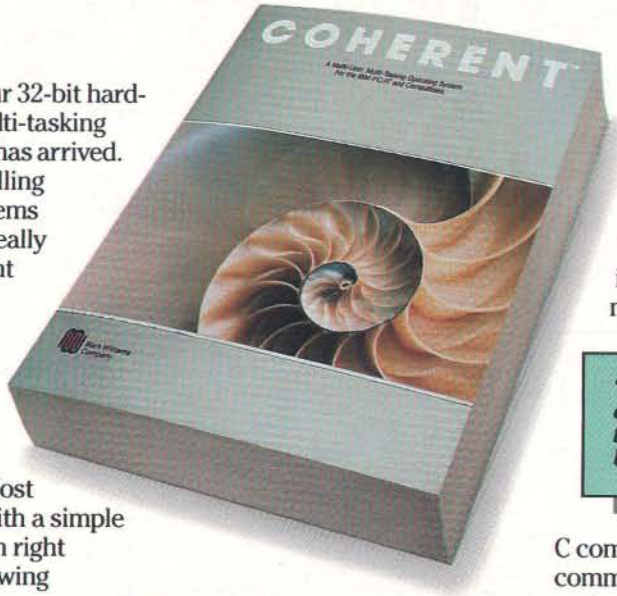

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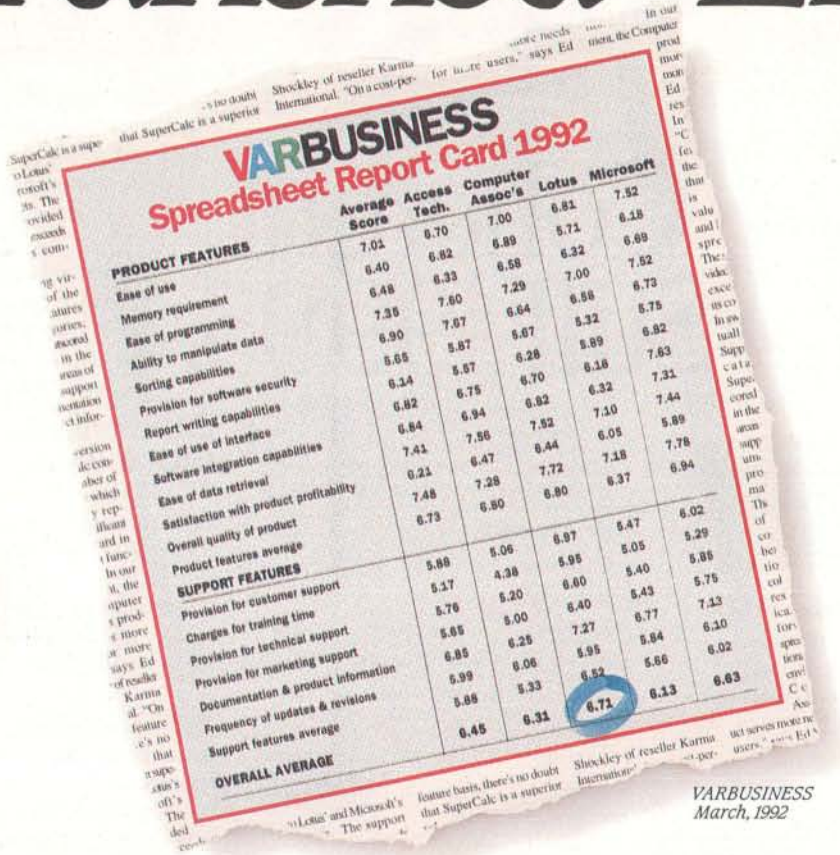

VARBUSINESS
Spreadsheet Report Card 1992

	Average Score	Access Tech.	Computer Assoc's	Lotus	Microsoft
PRODUCT FEATURES					
Ease of use	7.01	6.70	7.00	6.81	7.52
Memory requirement	6.40	6.82	6.89	5.71	6.18
Ease of programming	6.48	6.33	6.58	6.32	6.69
Ability to manipulate data	7.35	7.60	7.29	7.00	7.52
Sorting capabilities	6.90	7.07	6.64	6.58	6.73
Provision for software security	5.65	5.87	5.67	5.32	5.75
Report writing capabilities	6.14	5.87	6.28	5.89	6.82
Ease of use of interface	6.82	6.75	6.70	6.18	7.63
Software integration capabilities	6.84	6.94	6.82	6.32	7.31
Ease of data retrieval	7.41	7.56	7.52	7.10	7.44
Satisfaction with product profitability	6.21	6.47	6.44	6.05	5.89
Overall quality of product	7.48	7.28	7.72	7.18	7.78
Product features average	6.73	6.80	6.80	6.37	6.94
SUPPORT FEATURES					
Provision for customer support	5.88	5.06	6.97	5.47	6.02
Charges for training time	5.17	4.38	5.96	5.05	5.29
Provision for technical support	5.76	5.20	6.60	5.40	5.85
Provision for marketing support	5.65	5.00	6.40	5.43	5.75
Documentation & product information	6.85	6.25	7.27	6.77	7.13
Frequency of updates & revisions	5.99	6.06	5.95	5.84	6.10
Support features average	5.88	5.33	6.52	5.86	6.02
OVERALL AVERAGE	6.45	6.31	6.71	6.13	6.63

VARBUSINESS
March, 1992

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Circle 85 on Inquiry Card.

Lower the Voltage, Raise the Power

Advantages of 3.3-volt technology include higher performance, low energy consumption, and smaller systems

JEFFREY D. SHEPARD

Higher clock speeds, faster data communications rates, lower energy consumption, and smaller and lighter systems are being made possible by emerging low-voltage (i.e., 3.3-volt) technologies. Users of all classes of personal computers will enjoy more functionality as a result of the new technologies. Hybrid 3.3- and 5-V systems are now here. Chip vendor AMD claims that within six months, the first completely 3.3-V palmtop systems will be introduced.

Among the first new varieties of computers to use low-voltage technology will be ultracompact, fanless desktop machines consuming under 30 watts, 486-based subnotebooks weighing under 3 pounds with VGA video, and application-specific palmtop computers that run on AA batteries.

Low-voltage computing is expected to migrate from the palmtop to the desktop by early 1994. Industry leaders predict that shortly after that milestone is reached, the highest-volume microprocessors will be of the 3.3-V variety. The benefits, from energy conservation to raw computing power, all favor the dominance of low-voltage computing over today's 5-V technology.

New Voltages, New Microprocessors

The higher clock speeds possible with optimized 3.3-V chips will be a primary reason for the adoption of low-voltage technology in high-performance microprocessors. Designers are putting more logic on smaller and smaller dies using smaller transistors. These smaller transistors have less delays, which improves the clock speed.

Smaller transistors force the use of lower voltages because they can't withstand the electrical stresses of 5-V operation. Also, when a system operates at 3.3 V rather than at 5 V, its speed increases, because the transition time from a logic 0 to a logic 1 is less.

Intel's P5 may be the last generation of PC-level microprocessors that can be economically fabricated using either 5-V or 3.3-V processes, according to Ravi Nagaraj, senior applications engineer at Intel. Future generations after the P5 are expected to operate at 3.3 V or less.

The Alpha microprocessor from DEC is an extremely dense, high-performance (64-bit, 100-MHz) device. Because of the small transistor geometries needed, it cannot be fabricated to operate on 5 V and is offered only in a 3.3-V version.

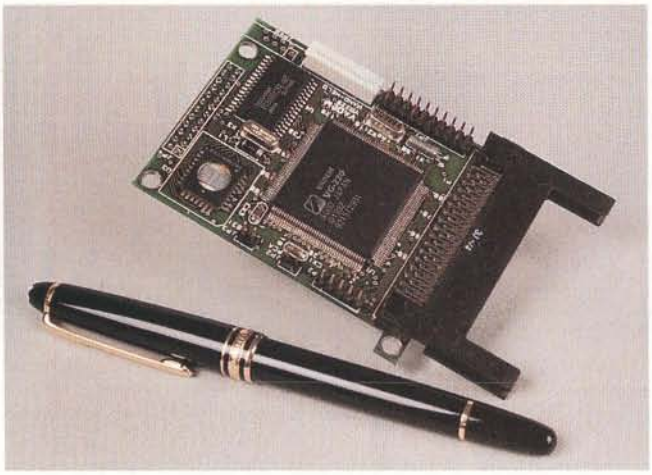
AMD and Motorola are examples of companies adapting existing designs to 3.3-V operation. Both companies recently announced 3.3-V versions of parts previously offered in 5-V versions only. AMD's 40-MHz 386DX and 25- and 33-MHz 386SX processors all operate on 3.3 V. The new lower power specifications for the Am386 devices provide a 28 percent

ILLUSTRATION: JAMES YANG © 1992

reduction in power dissipation over previous specifications.

Because power is proportional to voltage squared, the most efficient voltage to use for any system is the minimum voltage at which the system operates. A change from 5-V operation to 3 V can result in a factor of 5 in power savings. Most 5-V CMOS parts operate at 3 V, but they operate slower.

Lowering the frequency (and voltage) while the system is processing doesn't by itself reduce the energy used; it simply spreads the same energy over a longer period of time. On the other hand, lowering the frequency (and voltage) while the system is performing less intensive tasks (e.g., word processing) and raising it when the system is performing more intensive tasks (e.g., spreadsheet recalculations) reduces overall energy consumption.



Vadem recently introduced the VG230 subnotebook engine, a single-chip DOS-compatible computer. The 160-pin device is offered in both 3- and 5-V versions and contains an 8086-compatible 16-MHz NEC V30HL microprocessor core.

Except for the electrical specifications, Motorola's 3.3-V 68340V is identical to the original 5-V 68340. The new 68340V dissipates just 140 milliwatts from a power supply of 3.3 V when clocked at 8.3 MHz. By contrast, the 5-V 68340 dissipates 650 mW when clocked at 16.78 MHz. By design, Motorola's 68000 32-bit products are well suited to power-critical applications. For example, the 68300 family is a low-power HCMOS static design with specific features that let software adjust power consumption according to performance demands.

These chips also illustrate the trade-off between operating voltage and clock speed that exists in most of today's 3.3-V microprocessors. In most cases, the 3.3-V devices are "recharacterized" 5-V parts.

For example, the Motorola 68340 is fabricated using the same masks in both the 3.3- and 5-V versions; the only difference is the electrical characterizations and maximum clock speeds. The 3.3-V version is slower than the 5-V chip. The same is true of the majority of today's 3.3-V microprocessors. When dealing with devices optimized for operation at 5 V, operation at lower voltages leads to slower clock rates, primarily due to higher capacitance effects inherent in the relatively large geometries of 5-V devices. Chips optimized for 3.3-V operation, however, will operate at the same or higher clock speeds than their predecessors optimized for operation at 5 V.

Some chip vendors have used low-voltage technology to develop new application-specific devices. The PC/Chip 8680 single-chip PC from Chips & Technologies was designed for palmtop systems and is specified to operate on any voltage from 3 to 5 V. In a single device, the PC/Chip 8680 implements an 8086-compatible microprocessor running at up to 14 MHz, IBM XT–equivalent logic, a CGA-compatible graphics controller, a serial port, and built-in power management.

The VG230 subnotebook engine from Vadem has been called a complete DOS-compatible computer on a single chip and illustrates another trend toward the development of flexible devices (see the photo). The 160-pin device is offered in both 3- and 5-V versions. It contains an 8086-compatible 16-MHz NEC V30HL microprocessor core and a set of functional blocks that can be optimized for specific applications.

Intel and VLSI Technology have joined forces to make chips that will let system makers build low-power hand-held computers compatible with the estimated 100 million 80x86-based PCs now in use.

"Everyone has such different needs, and system manufacturers are addressing specific niche markets," says Betsy Jones, a product manager at Intel. "Before, customization to specific applications was on the software side of the system; now we are seeing customization to particular user needs in both hardware and software. The result will be more choices for users."

Zenith Data Systems sees a future in customizing hardware. Instead of trying to develop one perfect PC, vendors will create multiple, limited-function, microprocessor-based devices. "We are getting to the point that we can talk about sub-$500 prices. At those prices, people will buy multiple devices," says Chris Gladwin, product strategy and planning manager for Zenith.

Low Voltage on the Desktop

While the impetus for using low-voltage components in portable systems is almost solely to save energy, desktop systems will turn to the new technology to offer extremely high levels of performance or to save energy.

Current high-performance microprocessors operate at 50 MHz. By 1993, 100-MHz systems will be here, and by the end of the decade, 500-MHz or higher systems will be common, says Richard Sites, a DEC senior consulting engineer and a key architect of DEC's Alpha CPU. Several PC makers are already examining 100-MIPS microprocessors in their development labs.

Today's high-performance devices operate on 5 V and often require heat sinks, fans, and other elaborate (and expensive) cooling techniques. In addition, the heat that these high-performance microprocessors generate requires that they be packaged in ceramic rather than in relatively low-cost plastic.

The large number of transistors in 100-MIPS microprocessors creates an even more critical heat problem. Zenith's Gladwin says that 3-V operation is necessary to meet the performance demands of future generations of PCs.

High-performance machines will not be the only ones turning to low-voltage computing. Conventional desktops are expected to turn to the power management and low-voltage technologies developed for portable systems to reduce their own energy consumption. According to the U.S. Environmental Protection Agency, office equipment is the fastest-growing electricity load in the commercial sector. Computer systems alone are believed to account for 5 percent of commercial electricity

Benefits of Low Voltage

- Higher performance
- Less energy consumption
- Smaller systems
- New kinds of small, powerful devices

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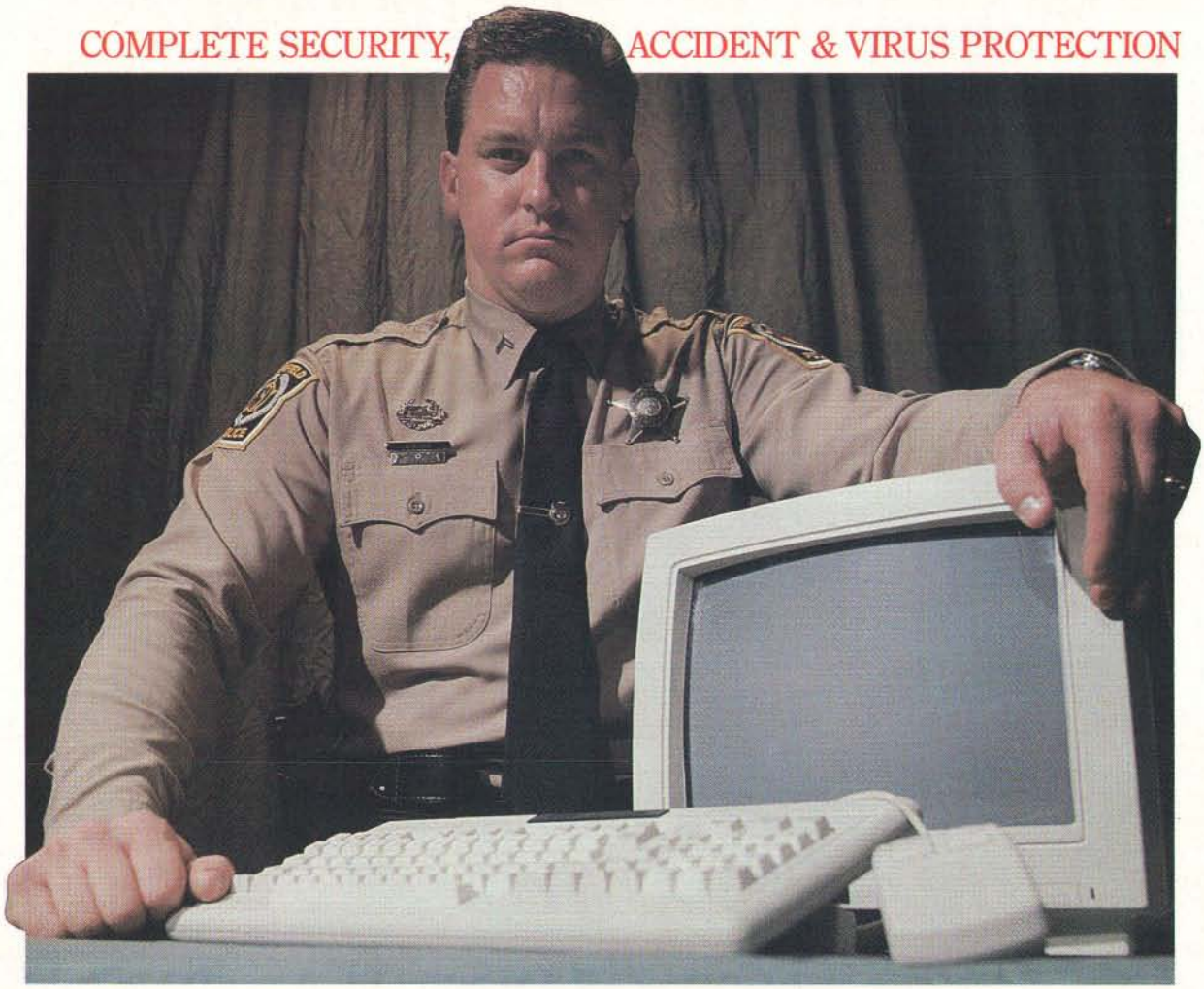

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Good-Bye RS-232, Hello 562

The move to 3.3-volt systems will cause two problems for today's RS-232 serial interface. First, no RS-232 serial interface ICs are designed to work from a single 3.3-V supply. Second, as the power consumption of palmtop computers is reduced, the power used for the serial interface becomes a higher percentage of total power dissipation. To support the emerging 3.3-V technology, a new serial communications standard, EIA/TIA-562 (Electronic Industries Association/Telecommunications Industry Association), has been developed.

The new standard also allows for compatibility with existing RS-232 interfaces. For example, 562 is compatible with printers, peripherals, and computers that have 232C, 232D, or 232E serial interfaces. Equally important, 562 allows and guarantees 64-Kbps operation, compared to the 232E specification limit of 20 Kbps. The higher data rate of the new standard allows various new applications to be developed, such as 64-Kbps synchronous communications.

EIA/TIA-562 has specifications regarding waveform shape and ripple that 232E doesn't include (see the figure). It's these additional specifications, as well as the increased maximum slew rate specification, that allow 562 to guarantee its higher-speed operation.

The more stringent waveform specifications of 562 ensure errorless operation at higher speeds. For example, a 562 driver must have ripple no larger than 5 percent of the voltage swing. The 232 specification allows the output of the driver to momentarily stop in the middle of the transition zone, as long as the total time required to move from -3 V to +3 V meets the specification. But if the driver output stops near the threshold of the receiver, the output of the receiver could make several rapid transitions, perhaps causing data errors.

EIA/TIA-562 interface ICs can use less power since the minimum allowable output voltage at the driver output is ±3.7 V, while the minimum acceptable 232E output voltage is ±5 V. This means that the minimum power delivered to the load by a 562 driver need only be 55 percent of the minimum power delivered to the load by a 232E driver. The power consumption is determined by the type of driver, not the receiver.

If you use a palmtop computer with a 562 interface IC, you'll enjoy the same power savings whether the equipment is connected to a 232 load or a 562 load. The only disadvantage of the new 562 standard compared to 232 is a reduction in noise margin from 2 V to 0.7 V. The noise margin is required to take care of several problems: external noise pickup, cross talk or coupling of signals between wires in the cable, and differences in ground voltages.

Most serial-interface cables are shielded, and you should experience no problems with external noise pickup, regardless of the interface standard used. The coupling (i.e., cross talk) of signals via the mutual capacitance between wires in the cable is most often a problem in systems that use the older (pre-232) drivers. The newer standards have a maximum slew rate specification (the maximum rate of change in the signal voltage) of 30 V per microsecond. The maximum slew rate reduces the amount of coupling or cross talk.

Differences in ground voltages can be a significant problem for users of serial interfaces when the two pieces of equipment are powered by different AC power outlets that are not grounded to the same point. The difference in ground potentials is typically several volts, and neither 232E nor 562 will work when there is such a big difference. In those few cases where the ground voltage difference is greater than 0.7 V and lower than 2 V, a 562 system may not necessarily work, but a 232E system will work.

Designers have been designing 562-like devices for years. Lower voltage parts and parts that do not meet the RS-232 voltage limits are commonly used for these designs. Apple, for example, uses its own, more stringent standard.

"If you look at the Apple interface for RS-232, it uses a chip that doesn't meet RS-232 standards, but it works with RS-232 very well. In fact, it doesn't even meet the new 562 standards, but it also works very well with 562," says Brett Fox, business manager with Maxim Integrated Products. Maxim has introduced the first serial driver IC designed to the new 562 standard, called the Max561.

Designed to operate at 3.3 V, the

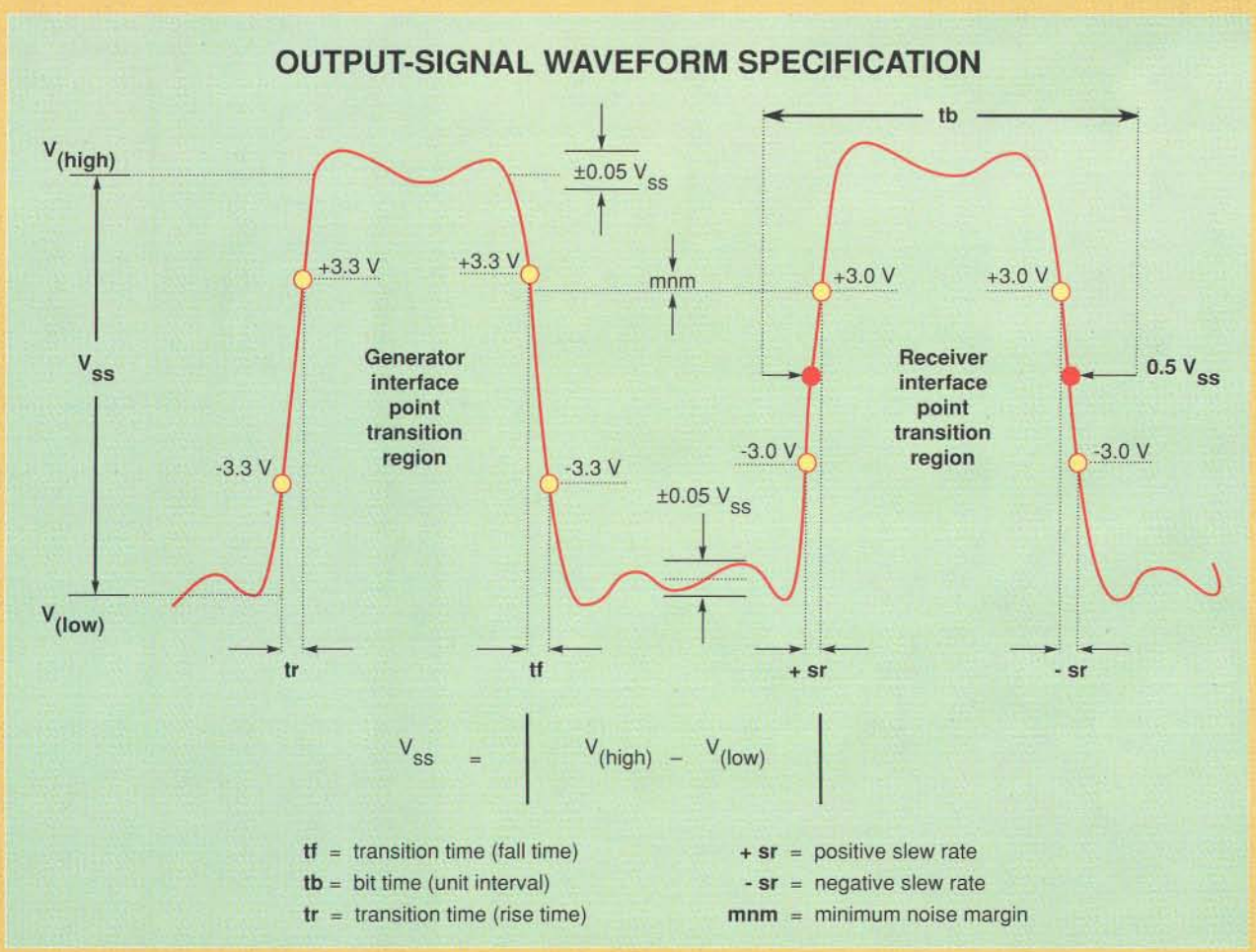
consumption and for potentially 10 percent by the year 2000. Systems left on but inactive (often overnight or through the weekend) consume energy needlessly (see "The Greening of Computers," September BYTE).

Howard Fullmer, executive vice president of system-design and consulting firm IQV, says that 3.3-V technology "could push the entire desktop market in the direction of ultracompact, low-power systems based on the PCMCIA card concept."

Within two to three years, active-matrix color LCD technology, PCMCIA expansion cards, and 3.3-V microprocessors developed for portable systems will be used in desktops, says Fullmer. VGA drivers, wireless LAN adapter cards, and a flood of other PCMCIA cards are expected before the end of this year. Anything found in desktop systems can be put on a PCMCIA card. According to Fullmer, the PCMCIA standard cannot accommodate mixed-voltage 3.3- and 5-V systems; however, existing PC bus structures do.

Hand-Held Voice Recognition

While the transition from 5 to 3.3 V has hardly begun, makers of microprocessors and RAM are already planning for devices with even lower operating voltages. There is a general acknowledgment that even lower voltages will be seen, but there is little agreement about what the next low-voltage standard will be. Devices are being planned with operating voltages of from 1 to 2.7 V. Hitachi recently disclosed the development of a 4-Mb



The output-signal waveform of EIA/TIA-562 has more stringent requirements for transition times and slew rates than that of RS-232.

Max561 absorbs 12 microamps of quiescent current, about 30 percent of the power used by traditional 232 transceivers. It also has the ability to go into partial shutdown by monitoring the line and turning on the port only when its receiver sees activity, further reducing power consumption.

In addition to providing lower power consumption and potentially faster data transfer rates, 562 driver/receiver ICs used in portable systems will be less expensive than 232 parts. The internal circuitry needed to make a 3.3-V 232 chip is more complex and occupies more chip area (resulting in higher costs) than the circuitry needed to implement an inherently 3.3-V 562 IC.

CMOS SRAM (static RAM) that operates on 1 V and a DRAM that operates on 1.5 V.

RAMs such as these are expected to find widespread use in the palmtop market. "By 1995, we expect to see hybrid designs that are below 3.3 V. The capability exists to go below 2 V," says Subodh Toprani, director of marketing and system engineering with the PC division of AMD.

As an example of the high-performance segment of the PC market, the next generation of DEC's Alpha 64-bit microprocessor is expected to be a 2.5-V device operating at between 300 and 500 MHz, according to DEC's Sites.

Today, a 386 microprocessor contains about 375,000 transistors, while a 486 has about 1.2 million transistors. By the end of the decade, microprocessors running at 500 MHz and containing 40 million transistors are expected to be available. By the year 2000, low-voltage technology will make enough transistors available on a single IC that if voice recognition is needed in a $995 machine, it will be on the same chip as the microprocessor. New output methods, such as 3-D graphics now seen in workstations and the voice and sound capabilities of multimedia systems, may one day be found in low-cost hand-held machines. For the desktop, compact 64-bit machines running at 500 MHz are expected to be available. ■

Jeffrey D. Shepard is a freelance writer living in Corona, California. You can contact him on BIX c/o "editors."

ILLUSTRATION: BOB SCOTT © 1992

OBJECTS FOR END USERS

Object orientation is not just for programmers anymore

CARY LU

For over a decade, visionaries have been pushing object orientation as the best way to deal with the enormous difficulties inherent in developing software. More recently, companies such as Apple, Go Corp., and IBM have been hawking the benefits of object-oriented operating systems, and a number of smaller companies have made the case for object-oriented databases. However, for most people outside the software development community—which is just about everybody who uses a computer—object orientation has been only of peripheral or academic interest. After all, how is a programming paradigm going to help you produce your next quarterly sales report?

The answer to that question lies in the DOI (document-oriented interface). Built on—and intimately tied to—an object-oriented foundation, the DOI is a more powerful and intuitive way to work with your computer than any of the other available interfaces. Instead of emphasizing the individual software programs that you need to do your job, the DOI concentrates on the task at hand, such as producing a quarterly report or the specification for a new widget, and it orchestrates transparent access to and cooperation among the necessary software programs. From an end user's standpoint, DOI computing is the logical culmination of the object-oriented revolution. It provides a natural way of interacting with the daunting world of objects (see the text box "What's in an Object?" on page 148).

Two Sides of the Coin

The DOI isn't here yet, but given the companies behind it, you may not have to wait long to see it. The vision of using documents as a natural vehicle for interaction between users and computers has been adopted by Microsoft for an upcoming version of Windows (code-named Cairo) and by Apple, which has slated it for the Mac. Taligent, the Apple-IBM joint venture, is also developing an object-oriented operating system, named Pink. Given the enormous installed base of command-line and GUI-oriented systems, it's obvious that the transition to the DOI will not be short or without a certain amount of dislocation on the part of both end users and software developers. What's just as obvious—at least to the Microsofts and Apples of the world—is that moving to this interface is worth the effort.

The DOI is an advanced user interface that makes documents, not applications, the focus of personal computing. Optimists believe that the DOI will usher in a golden age of computing where virtually all documents and software will be compatible, software development will be quicker, and any software developer who has a good idea will have a fair chance in the marketplace.

Pessimists believe that the industrywide standardization and cooperation necessary for the DOI to work will be difficult or even impossible to achieve. Software support will become a nightmare, because many problems will result from the interaction between products from different vendors.

Almost everyone agrees successful DOI computing would provide users with significant advantages. Mark Vickers, chief technologist for Taligent, predicts that new system software will "promote the development of [applications] software." And Jim Allchin, vice president for advanced systems at Microsoft and a manager of the Cairo project, believes the DOI will open up a new world where people can spend more

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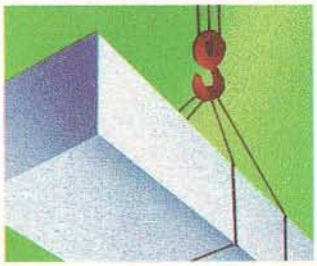

time thinking about how to solve problems and less time on how to run their software.

A Completely Different Approach

Today, you compute by first starting up a software application and then opening a document. Most electronic documents limit you to viewing and modifying them only with the application that created them. The DOI ultimately changes the structure of computing across the board, from what you see on-screen to how software operates to the file architecture on the disk drive.

To work in a DOI mode, you start by opening a document rather than an application (see the screen on page 146). The operating system, viewing software, or the document itself has the necessary code for viewing and/or modifying the contents. Documents can contain any kind of data object—text, graphics, sound, or full-motion video. Objects can be copied or moved anywhere in the document, placed in another document, sent over a network, printed on paper, or transferred to videotape.

Computing with a DOI would replace applications—as we know them today—with tools. For instance, instead of working in a massive word processing application with a laundry list of features, by using a collection of word processing tools (i.e., *applets*), you'd perform the same functions in a text object. A text object could be any size (as large as a book or as small as a graph's label), and you'd use the same text-editing tool with all of them.

Of course, any text tool (e.g., an editor, a spelling checker, or a typeface modifier) would work with any text anywhere, including text in a spreadsheet or names in a map. A page-layout tool would place and adjust text objects for the printed page, but unlike today's PageMaker-style programs, it would no longer need to incorporate text editing or spelling checking.

You could also mix and match tools. If you like your text editor but need more powerful search-and-replace features, change the search-and-replace tool and keep the text-editing tool. Do you need to put mathematical equations in a graph? Add an equation tool. For a portable computer with limited storage and RAM, you install just the essential tools rather than large toolkits or complete applications.

In any document, when you select an object, the appropriate tools would become available. The system might first look for the same tool that created the object; if that tool was not installed in your computer, the system would look for compatible tools. According to Tandy Trower, director of advanced-user-interface design at Microsoft, "The object could say, 'If you can't render me as an *x*, then render me as a *y*.'" If you had several tools with overlapping functions, you could tell the system which one you prefer to use. If no appropriate tools were available, you'd have to settle for only being able to view the contents of an object.

For a given document object type, there can be several levels of tools. The simplest is a viewer, and basic viewers will probably be built into the system software. For rare object types, the document might

The DOI

- Task-oriented
- Allows access to applications through documents
- Seamless and transparent integration of applications

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include a viewing tool. A software developer might give away viewing tools to promote the sale of a full-fledged editing tool that can create and modify objects. An intermediate class of tool might be able to view and extract static or dynamic information from an object but wouldn't have the ability to modify the object.

Objects will support and maintain links among themselves when you request this function. For example, a global search-and-replace function could apply not only to the text object on-screen but to any other document with that same object or to every text object on a network—if a company changed its name, you could replace every instance of it, even in the titles in a presentation video sequence.

Protection schemes would block inadvertent changes. Objects could also contain themselves, so version control would become much simpler (e.g., instead of separate files, one object could contain all the versions you want to preserve).

Developers and the DOI

Because it's based on object-oriented programming technology, the DOI will also have a profound effect on in-house and commercial developers. Says Taligent's Vickers, "If software developers' applications already share common features by the nature of the object code, we want them to be able to do new things directly without having to wait for a system software crew to come out with new interfaces.

"How quickly new software ideas are integrated will be the key. Today, if you have a new idea, you have to start from scratch. Now, software developers spend too much time maintaining applications for changes in hardware and system software; they don't have time to create new application categories.

"We have to change people's focus from having to rebuild the world from scratch; with objects, it's easier and faster to deliver new ideas and make money by leveraging on others' work. [We've] got to get the industry into a mode of being able to leverage its previous products rather than having to throw things away."

Today, using Macs and Windows frees programmers from having to fuss with printer drivers, file handling, or interface details, such as window management. But to create a product, a software developer usually must write either an entire application or create an add-on product that will work only with a specific application.

Building a full-scale application is usually beyond the capability of a small developer, and the market for add-on products is limited. For example, a Lotus 1-2-3 add-on doesn't work with Excel. In DOI computing, a software developer with a good idea can focus on that idea instead of producing an entire application. In a DOI environment, competition could be fierce because all DOI tools would be universal and compatible with all other tools. "With the DOI," predicts Chris Espinosa, Apple's Taligent business manager, "you aren't locked into buying from a particular vendor; vendor-hopping and stealing market shares would be much easier."

Working Together

How will the small developer be affected by the coming of the DOI? In a speech to Windows developers last year, Bill Gates proclaimed that DOI computing would lead to a golden age for small developers. David Canfield Smith of Apple's advanced technology group thinks that [in a world with the DOI,] "the rate of progress would shoot up, and people would come out of

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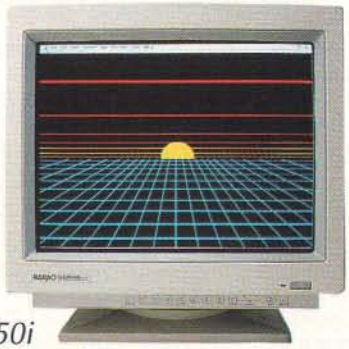

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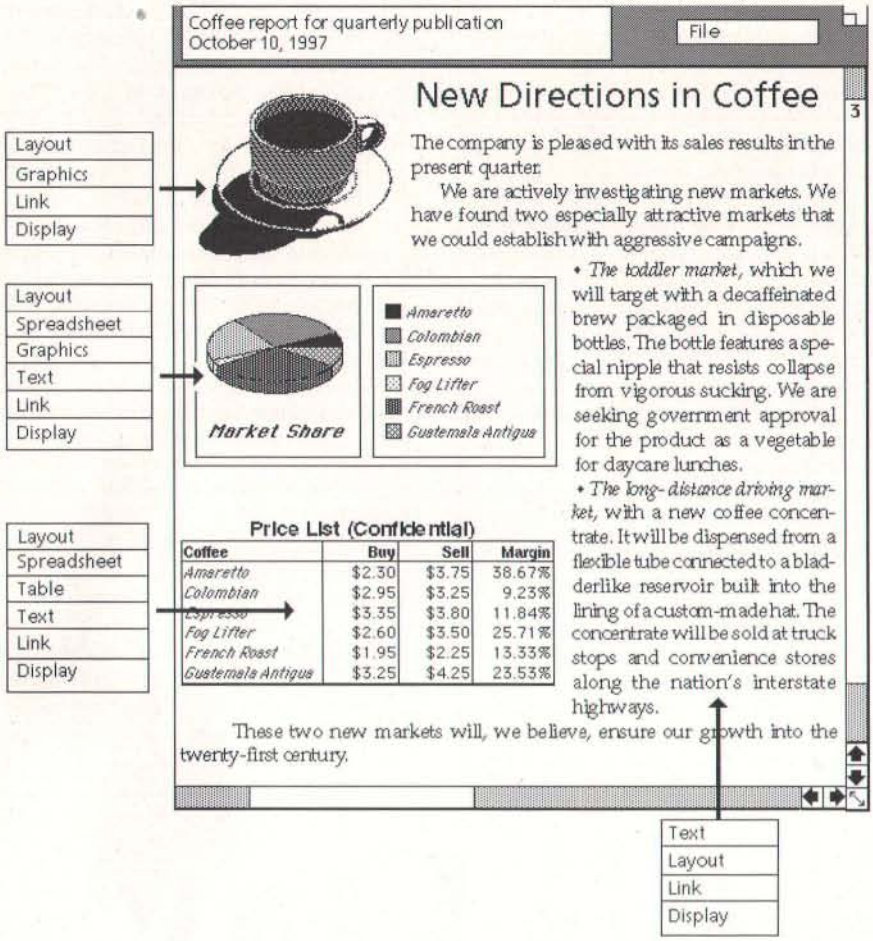

When you select an object in a DOI, a pop-up menu offers the relevant choices (e.g., a layout tool or a text tool). Relationships to other objects can be found or established with the link tool.

the woodwork." Some small companies, however, are less sure of the future.

Developers in small firms could produce great tools, but any good idea would still be taken over by big companies and added to their growing toolkits, just as spelling checkers, once sold by small companies, are now included in all word processors. If today's $300 massive application is replaced by a $300 package of a dozen tools, can anyone sell a replacement tool for $25 and make money? Some small developers believe the DOI will make development easier, but they also think that their markets will remain the niches that are too small to interest the big players.

Dick Phillips, a member of the technical staff at Los Alamos National Laboratory, developed MediaView, an object-oriented viewer for the Next computer. For DOI computing to work, he cautions, "there will have to be intense industry collaboration. This scenario is antithetical to competition. I don't know the answer."

The DOI doesn't require that a class of tools (e.g., text-editing tools) adopt a standard file format. Such tools can use a proprietary method of coding and storing information in an object, but the object must send and receive information in a form that other objects and tools can understand. There appears to be no technological barrier to this, but a vast range of issues and details remains to be worked out.

In principle at least, you should be able to use a Lotus Ami tool to edit a text object created by a WordPerfect tool and vice versa, even if each tool uses a proprietary data format within its text objects. The tools and objects should perform any necessary conversion transparently. "Objects will force programmers to pay more attention to protocols and interoperability," says Taligent's Espinosa.

How will interoperability be accomplished? According to Espinosa, there are three possible modes. In mode one, "developers turn their backs on each other, look to see who has survived, and then build bridges to the surviving products out of sheer necessity. In mode two, a dominant company sets the de facto standard and everyone follows, sometimes pushing the standard and dragging the dominant company along.

"Two powerful players are in the game: Microsoft and the Taligent combination of Apple and IBM. And, to some degree, Sun Microsystems and Hewlett-Packard are also factors. Adobe is small but has key leverage [through its PostScript standard] against others in the industry—especially with Apple, HP, and Microsoft. In mode three, nondominant players get together and create a de jure standard."

Getting to the point where DOI computing would be commonplace could happen either incrementally or as a result of a major change. Microsoft is taking the incremental route with Windows. As Microsoft's Allchin says, "I don't believe in discontinuities. It is a rare occurrence when someone comes out with something radical that works."

Apple is trying both approaches. The Mac System Software Group believes in incremental improvements to the Mac OS, but some of Apple's senior executives think Taligent's more radical departure will yield a stronger foundation. According to Taligent's Vickers, "We will start with raw hardware and build the entire system. We want to inspire [the creation of] a new generation of hardware—both computers and networks." But Vickers stresses that "compatibility with existing systems is very important."

Taking the Hurdles

The first steps toward creating the DOI have already been taken. The most DOI-like system today is PenPoint, the pen-based operating system from Go Corp. (see the text box "Objects and PenPoint" on page 158). In this operating system, the pen tool controls all pen input for every application. Next year, Microsoft plans to release OLE 2.0, a protocol that enables Windows documents to contain information from several applications.

Apple has two technologies that compete with OLE: AppleScript and Bento. AppleScript gives applications a protocol for exchanging commands and data.

According to Jed Harris, Apple's Bento software architect, "Bento, named after the Japanese word for a tray with compartments for food items, is a library for reading and writing compound documents. The content of a file is open-ended. A Bento file is very inspectable, because information on how to read the data is explicit and accessible. Your computer can

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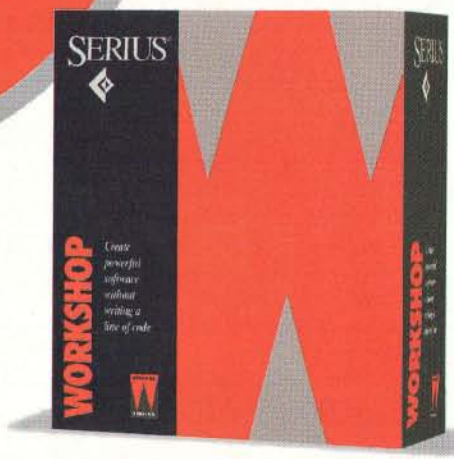

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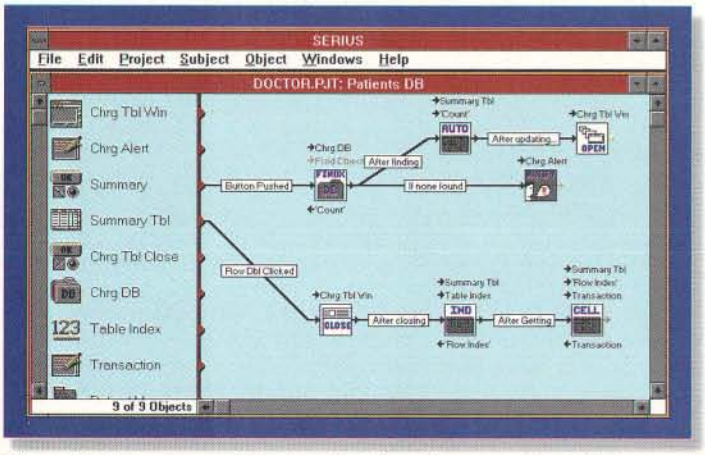

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What's in an Object?

MARK CLARKSON

An object is just a chunk of data. But unlike passive chunks of data, which just lie there letting procedures manipulate them, an object can be active data. An object might be a number, a word, a spreadsheet program, or a digital image of an IC. If a number, it may know how to double itself, compute its reciprocal, or multiply itself by pi. You elicit these actions by sending the object a message telling it to perform some action.

Objects manipulate themselves; nothing reaches inside and stirs their contents around. Their interfaces are clean and distinct. They send and receive messages—nothing more. Objects are private, insular, self-contained, and inviolate.

A class is a group of objects that share the same behaviors and capabilities. Consider a class of objects called animals. If one animal can breathe, eat, and reproduce, all animals can.

You can create a subclass of objects, which has special capabilities. For example, mammals are a subclass of animals, with their own unique capabilities—the mothers make milk for the babies. Similarly, subclasses can be further broken down into other subclasses. You could move from mammals to humans to children to little girls, and so on, ad infinitum.

Each subclass inherits all the capabilities of its parent class (or superclass). Because animals can breathe, little girls can breathe. And if you add a new capability to the class, that new capability is inherited by all the subclasses. If you say animals can now zoom around like Superman, little girls inherit the gift of flight.

The reverse, incidently, is not true. It does not follow that if little girls can jump rope, all animals can. Inheritance only flows downhill.

Better, More Consistent Software

The encapsulation provided by objects lets developers create complex applications out of relatively simple and easy-to-debug objects. According to Keith Wales, vice president of R&D for PenMagic (North Vancouver, Canada), "the first thing you should get out of [object technology] is better software. Software should be more consistent, smaller, and more error-free."

Objects represent software components that have been extensively tested. If a company is building two different applications that share some functionality, its developers can write the applications so that the shared functionality is embodied in shared objects. One application might be a specialized subclass of another. With object orientation, code reuse becomes convenient—almost inevitable—reducing development time. Thus, objects make it unnecessary to reinvent the wheel each time you write an application.

No Free Lunch, Yet

The benefits of object orientation don't come without some pain. For developers, the price is retraining a generation of programmers immersed in the procedual programming paradigm and reworking existing code so that it can exist in an object-oriented framework.

For end users, the price is speed. There is overhead involved in all these messages being passed to and fro. Although an object-oriented operating system provides capabilities that a standard operating system can't, simple things (e.g., copying files) can take longer to accomplish. But the benefits to both developers and end users make the costs well worth bearing the pain.

Mark Clarkson is a freelance science writer based in Wichita, Kansas. You can reach him on BIX c/o "editors."

look inside the file and display any contents that it can handle. Any application [or tool] that comes with the Bento library has this feature."

This year, Adobe is planning to release a document-interchange format for electronic documents, code-named Carousel. Frank Boosman, senior product marketing manager at Adobe, says Carousel will "enable people to exchange documents that retain their look and feel after the exchange. In the first version, you won't be able to edit a Carousel file, but by version two, we will add that capability."

For the Bento project, Jed Harris points out that Apple is "working with Adobe to make sure Bento and Carousel will work together. We don't define how to render information on-screen; Adobe has a well-developed concept of how to do that. In the short term, the natural thing to do is to combine Carousel and the original files and bundle up everything in Bento. In the long term, we want to converge on a common format." The results won't be an Apple-proprietary format. "We want to hand it off to an industry alliance," says Harris.

Meanwhile, Microsoft has announced extensions of OLE for the Mac environment, and Apple will offer AppleScript and Bento for Windows. Bento is already running experimentally on Windows, DOS, Unix, and the Mac. Conceivably, more than one DOI standard will be adopted by the industry. Translation between multiple object protocols is possible, although some features undoubtedly will be lost. Enactment of multiple standards is almost inevitable for the many new kinds of digital devices that appear on the market (e.g., hand-held digital organizers and electronic newspapers).

Dealing with Diversity

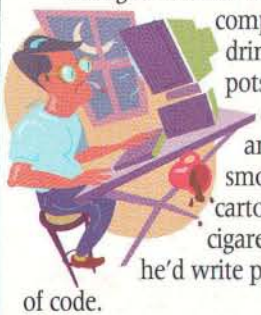
The number and complexity of available and soon-to-be available object protocols place a great burden on end users. In the short run, you will have to cope with many issues. For instance, an object can have several representations: a static PostScript-like view, a dynamically linkable version, and a native data format. If you use a specialized object for which you lack an editing tool, should you include only a static view, or the entire object in case someone might need to modify it?

Embedding a graphic in a document seems simple, but what if you were to change and enlarge the graphic? Should the document shrink the graphic to fit? If

Why do they call it a dongle?

He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.



It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

The Most Powerful Program in the World

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So he sold a few. Only a few.

Back in Boston he waited. After a long year with only 13 orders he set out to see what happened. As he drove across the country and flew around the world he discovered everyone knew about his program. Everyone had it too.

The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.

Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

Call It What You Like

He developed a hardware key. His peers applauded his efforts. Finally, a solid solution for revenue protection.

But he didn't know what to call it. He thought of naming it after an exotic place he visited in his travels. Madagascar was a bit too long, though.

"Name it after you, Don!", urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall—the lonely software developer who did what he had to do.

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one item shrinks to invisibility, should the document be reformatted? Should you be alerted about the change? Changing a frequently used object (e.g., the boilerplate for a legal contract) might result in changes in hundreds of other objects.

You must plan ahead when you use objects. For example, a company logo could be an object. If you change the logo, every document—electronic or paper—changes as well. What if the new logo runs down the left side of the page and the old one ran across the top? You could scramble every document because you treated the logo as a dynamic object.

Not a Free Ride

For all its advantages, the DOI is not risk-free. "Beware of the idea that objects will solve everything," warns Taligent's Vickers. Already manufacturers are finding it hard to support the interaction of different products; what happens when almost everything involves interactions?

DOI computing doesn't require new hardware, but the computing necessary to support dynamic links and data conversion among object types will consume considerable processing power and require higher network bandwidth on future computers. For Cairo, Microsoft is building a file system that differs from DOS's file-allocation table and the HPFS (High Performance File System) developed for OS/2.

"It is very hard to find things and organize things, very hard when you want an object-oriented view, very hard to map into the traditional file system what the user interface wants," says Microsoft's Allchin. "The current file systems don't store small objects, embed variable elements within a file, or store relationships and transactions. There are object-oriented databases and file systems. But we are building something in the middle: We are creating the *object filing system*."

Microsoft is patenting its ideas on how to find things fast on both a volume and a network; Allchin promises Microsoft will publish the protocols for the filing system. But the company will support the existing DOS file structure for users with networks and storage devices, where compatibility is more important than performance.

DOI computing should cover systems from laptops to high-end machines, but it will not affect small pocket organizers. "The super-low end is not part of it; the user interface design does not necessarily apply. Small screen sizes cannot handle big displays, and small images do not scale up," observes Allchin. "We are trying to take the machines that are popular today and make them better."

Vickers says Pink will "target high-volume hardware platforms. What has driven us in our design is that not everyone will use Pink, so Pink has support for digital multiculturalism. If one person with a Pink system connects to a network composed of other operating systems, he or she can at least connect and preserve data, maybe even programs. We connect to networks through high-level object-oriented abstractions, so we can connect and respect the idea of there being many standards."

Because document objects will often be carried in portable devices, all the system software under development will have features for intermittently connected computers. Objects stored on any device can be updated automatically on reconnection.

"We are redoing the user interface for Cairo," Allchin says. "We want to leverage the object rather than the overall document. The context menus will apply to

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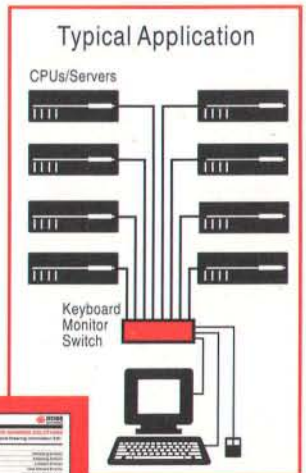

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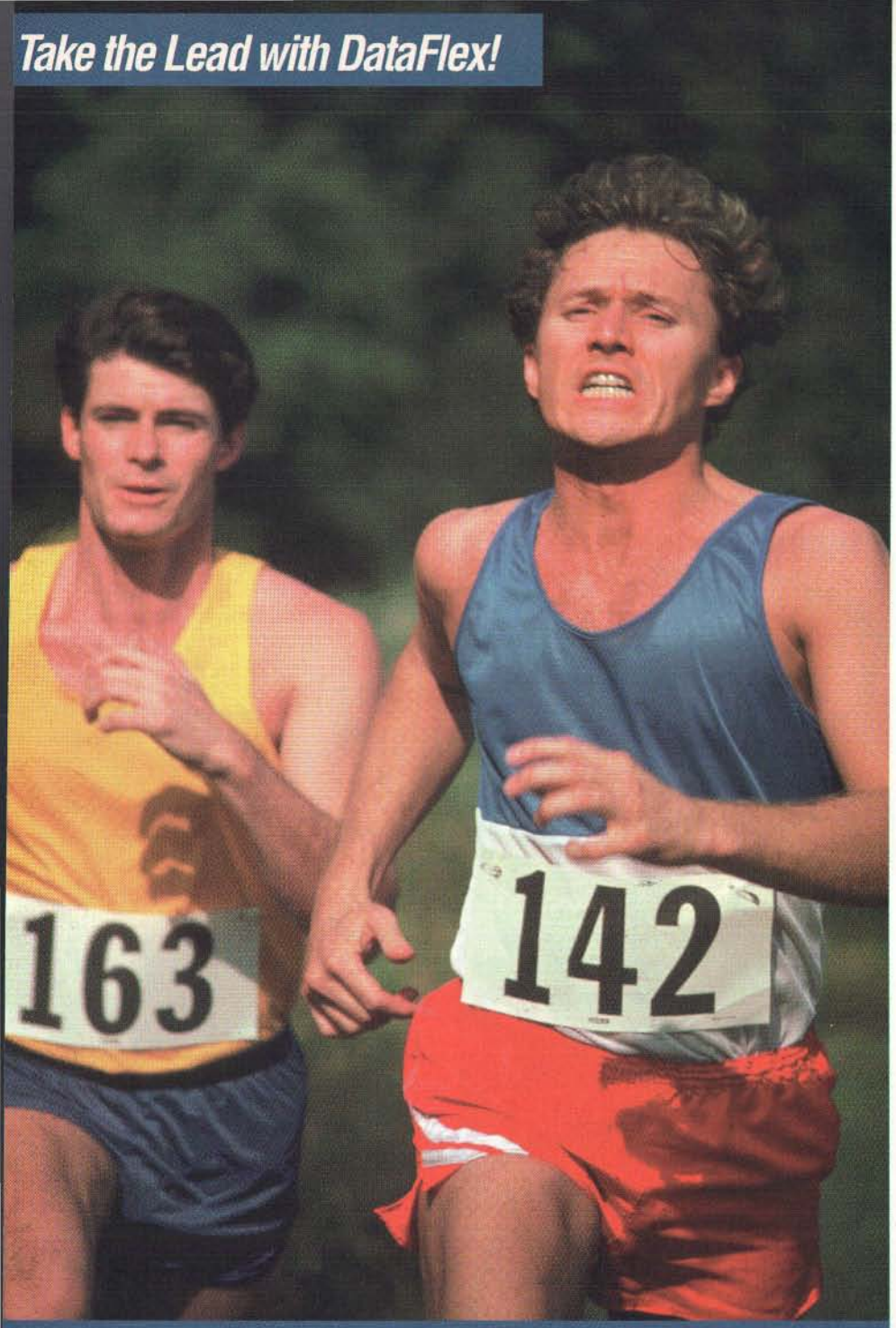

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objects. You basically see that the user interface becomes a minimalist approach to glue objects together, to organize objects, and to help find objects.

"We can do a lot better metaphorically than the representation of file cabinets in today's interface—we can organize information the way you organize your desk. We want fast ways to find stuff, particularly on a network. The current eight-dot-three names and directory structure are very poor. [We'll] have both the navigation approach and the query approach. It's not just promises. We have code running."

The Advanced Technology Group at Apple has been studying many interface enhancements for DOI computing. Among the enhancements are translucent layers over documents for annotations, "piles" of related documents, and the ability to riffle through thumbnail views.

DOI computing may bring many other changes. People have long talked about *agents*, pieces of software that can perform a task on their own. With the DOI, agents become easier to develop. David Canfield Smith of Apple says that "instead of a reactive machine, we will have a proactive machine that does things. With agents installed, the machine is never idle; it's always working."

Something New Under the Sun?

Although the DOI represents a significant advance in computer software and interfaces, the concept isn't new. According to Bruce Tognazzini, formerly of Apple and now interface evangelist at Sun Microsystems, "The plain-paper metaphor this idea [the DOI] is based on was invented 25 years ago. It could have been done five years ago but wasn't, because [developers] weren't ambitious enough. It requires a real partnership between system software vendors and applications vendors.

"One of the interesting things about the plain-paper metaphor is that it's as much a social problem as a technical problem. Plain paper requires that developers give up quite a bit more control over software design. [The DOI] requires a mature, sophisticated industry. This has held back the metaphor more than the technology. Users, however, gain a lot, because the interface is easier and cleaner."

Bill Verplank, one of the designers of the Xerox Star, the first commercial computer with a GUI, recalls, "At Xerox, we never wanted the user to see the workings of an application. With the DOI, there would only be documents and folders; you create or get frames and put them into documents. You wouldn't have to deal with separate applications."

Computer documents using the DOI gain some of the universality of paper documents. When you read a paper document, you don't stop to search for a text reader or a graph interpreter. You simply read. Similarly, you can put a DOI document in a computer and read it without searching for a compatible application.

The DOI will also make publishing and distributing computer documents easier than publishing paper ones. Publishers of electronic books, magazines, and newspapers won't have to cope with printing, shipping, and storing paper copies.

The time of the computer document is coming. It will probably be a golden age for those who are nimble enough—or powerful enough—to take advantage of it. ■

Cary Lu is the author of The Apple Macintosh Book *(Microsoft Press, 1992). He has done research on human vision at Bell Laboratories and the California Institute of Technology. You can reach him on BIX c/o "editors."*

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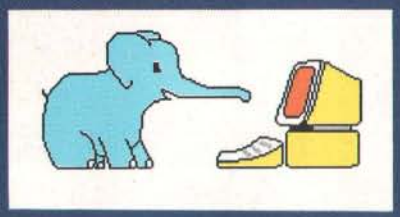

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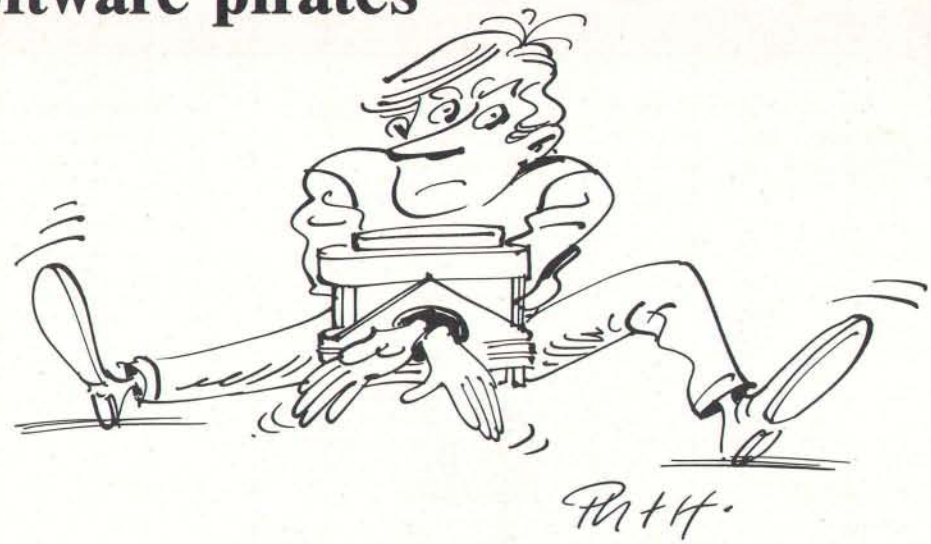

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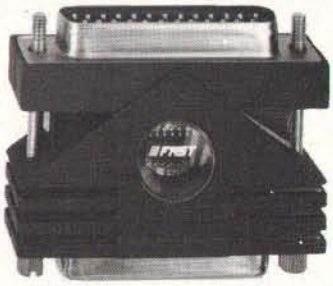

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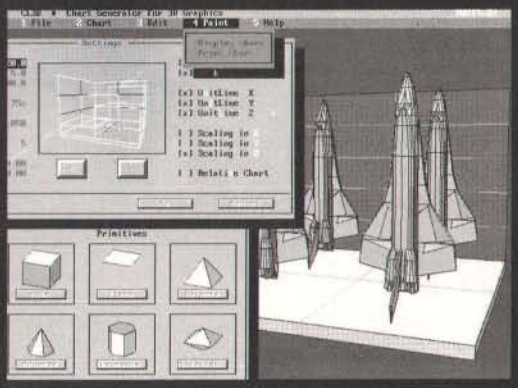

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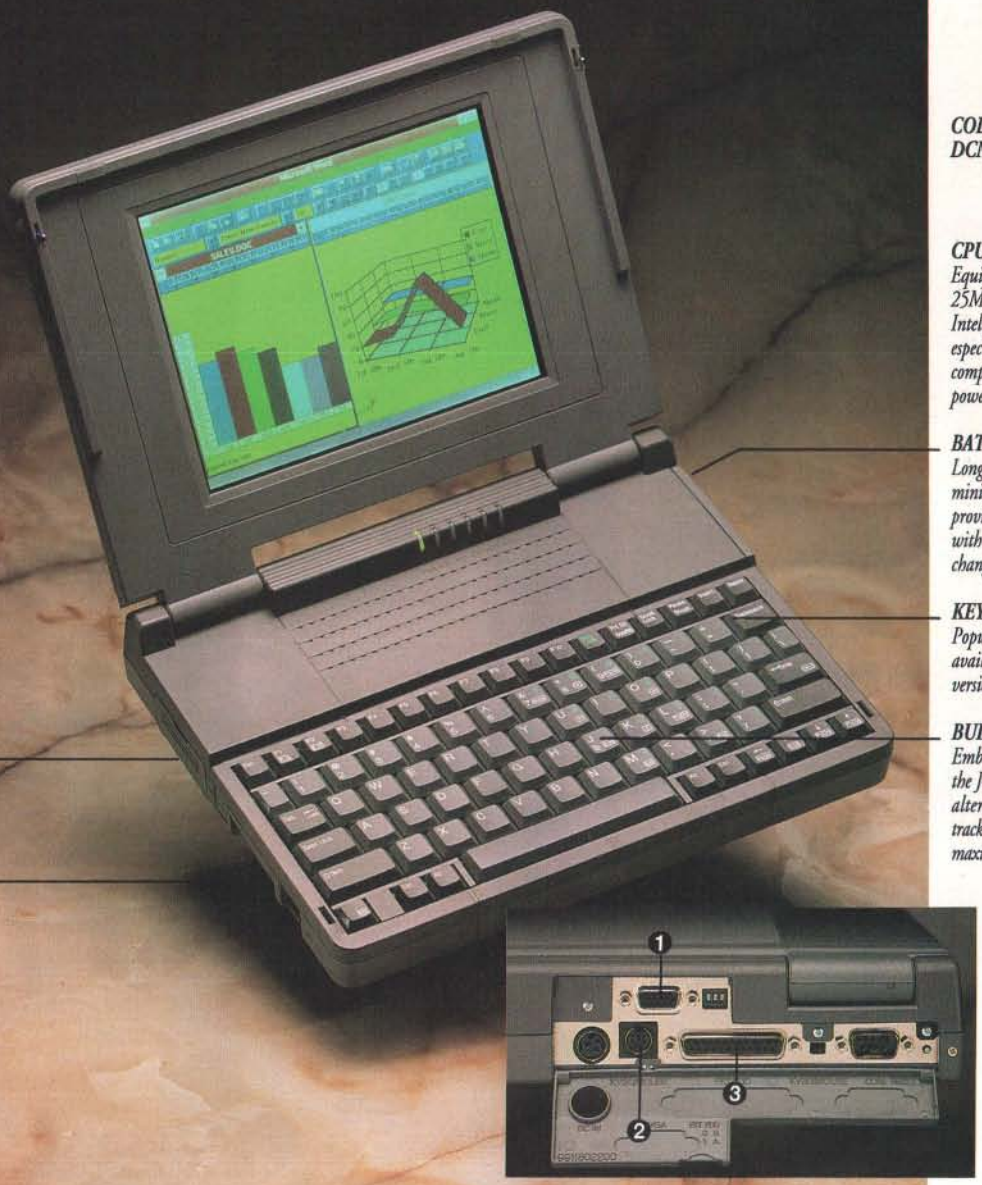

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BRAVE NEW DESKTOP

System software vendors are using object techniques to open up new vistas in the world of integrated computing

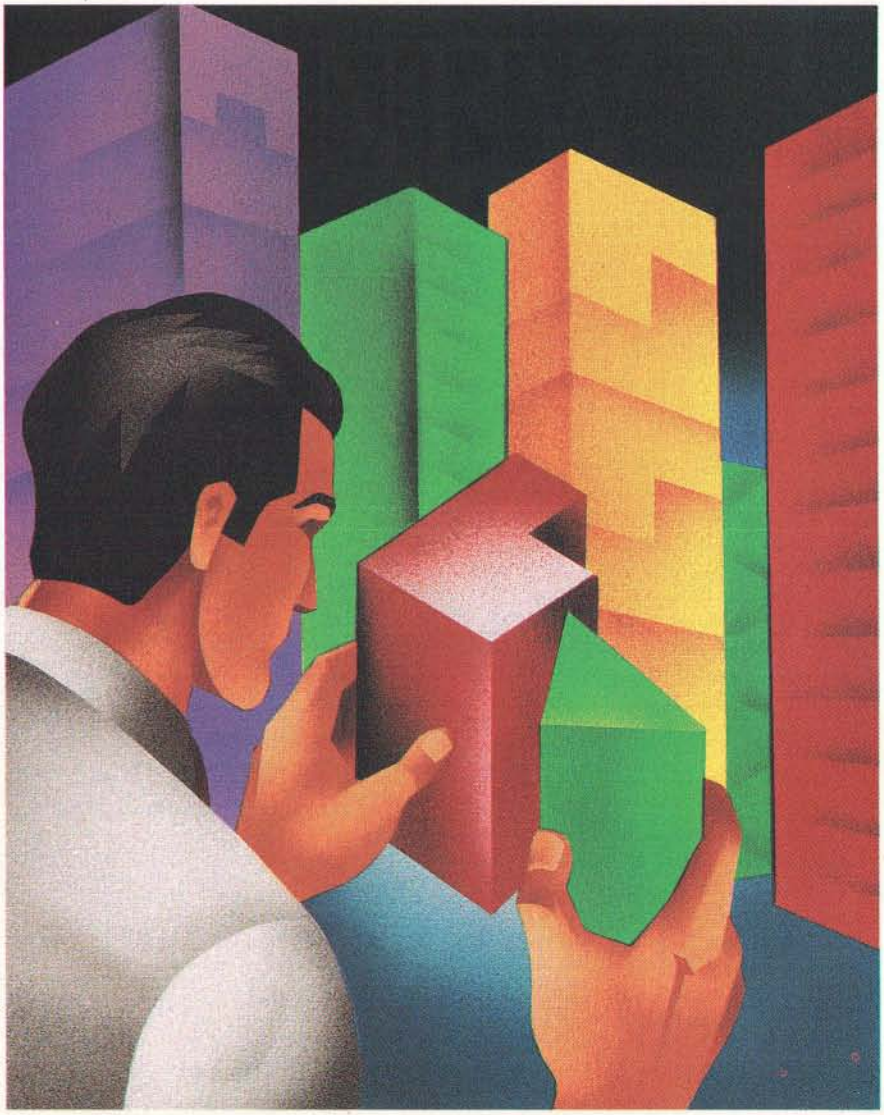
PETER WAYNER

In a classic line from the movie *The Graduate*, the character played by Dustin Hoffman learns from an overbearing relative that the key to future success is "plastics." If you talk to systems developers, they'll use the word *objects* with the same reverence, and they'll have the same idea in mind. *Plastics* and *objects* both convey the idea of flexible and mutable worlds, where form is easy to change and all-accommodating. That utopia is the goal of the designers of the latest versions of operating systems such as the Windows and Mac systems.

When you begin to compute using objects, you'll find that all your applications will automatically be able to communicate with each other. The change will be dramatic. The best manifestation of such an environment is the PenPoint operating system from Go Corp. (Foster City, CA) (see the text box "Objects and PenPoint" on page 158).

You won't work with a hard disk full of programs—you'll have a seamless system that will do just about everything you want without your having to slough your way in and out of a bunch of applications. As soon as more software is written for the newer systems, the applications running on your machine will be able to work together without relying on—or bothering—you.

What's more, you'll be able to create many push-button applications or macros that will string together commands that affect many other applications simultaneously. You won't "install a new spreadsheet application"; you will "integrate a new spreadsheet module into your object domain." And when the word processor of the future needs a file converted, it can



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request the result from an all-powerful file-conversion program. You won't have to do the conversion for it. In addition, all your applications will be able to share this central file-conversion software.

With the coming of objects, you'll also see the new operating systems providing better ways of automating familar chores. For instance, computer lab managers will be able to write scripts that will scan for viruses and reset a machine to a standard configuration after it has been modified by a user.

Objects will take many different forms. A number of companies are already making announcements concerning their versions of object-oriented software. Apple introduced Apple events with System 7.0 more than a year ago. And Microsoft is due to provide something with these features for Windows 3.1 using its OLE.

Meanwhile, established minicomputer manufacturers such as DEC and Hewlett-Packard are entering the field with their own interlinking environments, which can hook up applications and documents from different machines. OS/2 comes bundled with a scripting language called REXX, which is descended from the REXX (Restructured Extended Executor) used on IBM's mainframes. A version of REXX called AREXX is also the standard IAC (Interapplication Communication) language on Commodore's Amiga.

Workstation manufacturers are providing products that will link not only programs running on their systems but also programs running on the systems of other vendors. Sun Microsystems will offer Tooltalk and collaborate with HP. IBM is working with everyone. And Next is pushing to offer its object-oriented operating system on Intel 80x86 platforms.

Moving Toward Object Orientation

IAC and object-oriented technology have been around for some time. Mainframe operating systems and more general systems like Unix had object-oriented features long ago, although these features were not always classified as such. The designers of Unix let programmers take advantage of the system's modularity by supporting the creation and linking of a number of small, generalized programs. The system provides shell scripts, similar to a powerful programming language, that can run any program or application and feed its results into another program.

The textual nature of these earlier systems actually proved to be a big advantage. Because GUIs seem to have more ambiguity than their older textual counterparts, their use makes writing a meta-level control language difficult. In GUIs, dialog boxes can appear in different places or have different shapes, and screens can be different sizes. The big challenge for GUI manufacturers is to find a natural way to incorporate scripting and events into the graphical world. Text, on the other hand, is just text.

The REXX language is included by IBM with OS/2. A number of companies distribute their own versions of REXX. The language is powerful and clean but dated. Still, it's a big improvement over DOS batch files, because it contains all the control structures you expect in a high-level language. REXX is stable; it's been well developed over the years. Given its support on multiple platforms, it is sure to be with us for a while longer.

The Apple Pie

In 1991, Apple's new System 7.0 included many cosmetic changes to the user interface, but fundamental differences existed deep below the surface, where most users never dare to venture. Apple's gurus embedded in the system a new technology called Apple events, which allows applications running on the Mac to communicate with each other.

At the outset, only sophisticated programmers were able to take advantage of Apple events. It required a C or Pascal program to issue a system call with the message. Even the best programmers agreed that it wasn't easy to add event-parsing functionality to their software with the new technology. But once Apple events is built into the software base, life will become easier for everyone, and developers will be able to take advantage of features of other programs.

Apple defined a few simple events (e.g., `open a file` or `print a document`) and relied on developers to come up with additional features. One example is a freeware editing program called BBEdit. It can query the On Location indexing software to quickly search a disk for files that contain particular keywords. It sends the right `Events` message to the On Location program and waits for a response. The author of the program didn't have to build a

Key Players in Object Technology

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search-and-find command to maintain an index. He just planned ahead to use the Apple events link to On Location.

For the rest of us, uses of Apple events are starting to appear. The latest version of HyperCard can issue Apple events to Apple events–aware programs and to other versions of HyperCard running on the same network.

HyperCard is a more accessible language than C or Pascal, making it possible for many people to create systems that communicate among themselves. It is easy to imagine (and program) a network of HyperCards that exchange data and maintain a consistent database. Such a network might not be the fastest, but it would be easy to develop.

UserLand Frontier is a general front end for the Apple events package. With this central program, you can control all the Apple events applications. The UserLand Frontier software can issue Apple events commands to all the other applications on a disk. The front end also provides an editor and an outlining program with which you can easily string together many of these commands in a script.

The clever enhancements created for UserLand Frontier hint at the shape of operating systems to come. One simple command creates an icon that will compress objects into self-extracting archives. The program intercepts the `dropped on icon` event, translates it into a `turn into a self-extracting archive` event, and passes the new element to the compression program via Apple events.

UserLand Frontier includes various ways to access Apple events, and it's possible to create more complicated spin-offs. In the future, Apple will incorporate UserLand Frontier–like features in a technology known as *AppleScript*. This process will link all applications by the use of a common method of distinguishing mouse-clicks and similar features. With this capability, you will be able to build macros and scripts that operate on all "scriptable" applications.

Apple is beginning to discuss a new system called *OCE* (Open Collaborative Environment), which will provide deeper and more sophisticated file and networking commands. One will be low-level support for groupware applications, such as Group Technologies' Aspects. On the network, using the current version of the software, more than one person can edit a document concurrently. Changes on one version show on both screens, but you must be using the word processor and drawing program bundled with the system. Eventually, all applications will recognize these low-level OCE events.

Ultimately, file systems and networks will also become more transparent. System 7.0 already lets you "publish" and "subscribe" to files on the network and control their access. OCE will link most of these capabilities with the mail system and provide a file-store-and-forward mechanism. Right now, mail systems only handle text, but eventually they'll be able to allow all files to move transparently across the network.

In addition to the Mac file system's becoming more flexible, it will also become more secure. OCE technology will include system calls for digital signatures and secure public-key encryption. Using these features, you will be able to send sensitive documents over the network without worrying that they will be read or tampered with en route. The signature system is considered secure enough that payment vouchers can be exchanged over the network. Original signatures on real paper will no longer be needed to process documents.

Opening Up Windows

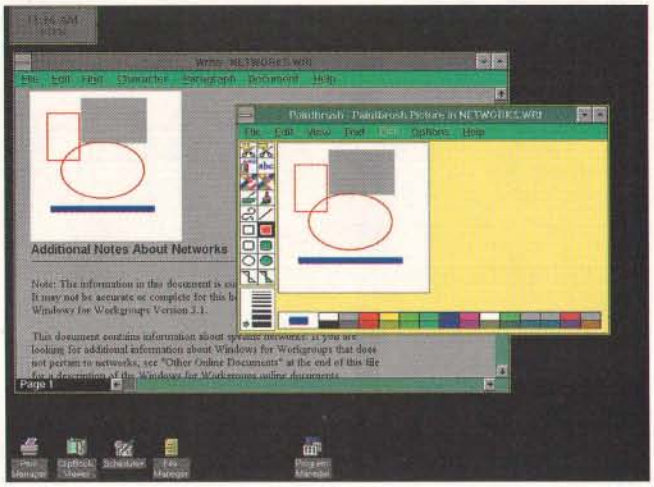
Microsoft is also pursuing a similar system of links and connections to run under Microsoft Windows. The first level is called DDE. With this toolkit, programmers can have Windows applications communicate with each other.

Symbiotics (Cambridge, MA) has extended the DDE protocol to work over a network with a product called Networks. With it, you can devise group-productivity solutions using existing Windows applications. Networks lets you create point-and-click connections between two Windows applications over a network.

Microsoft has built a more sophisticated protocol, called OLE 1.0, on top of DDE. OLE lets you share data from two different files in an object-oriented way. You can easily create a graph in a spreadsheet and paste it into a word processing document. You could do the same thing with the old paste command, but now the paste command can link the graph in the text document with the graph in the file created by the spreadsheet. If the numbers in the spreadsheet change, these links will carry the changes through to the final word processing document (see the screen).

The links can also work differently. Let's say you're editing a document that has a spreadsheet pasted into it and the spreadsheet contains an error. OLE 2.0 will let you click on the table of numbers and have the spreadsheet—Excel, in this case—take over the machine. The menus would change to Excel menus, and all commands except the `file open` and `save` commands would be passed directly through the word processor to the Excel application. Excel would hand off all screen-drawing commands to OLE, which would pass

The current version of OLE lets you embed links to objects in a document, but it doesn't allow you to edit objects in the document's edit space. Version 2.0 will correct this deficiency.



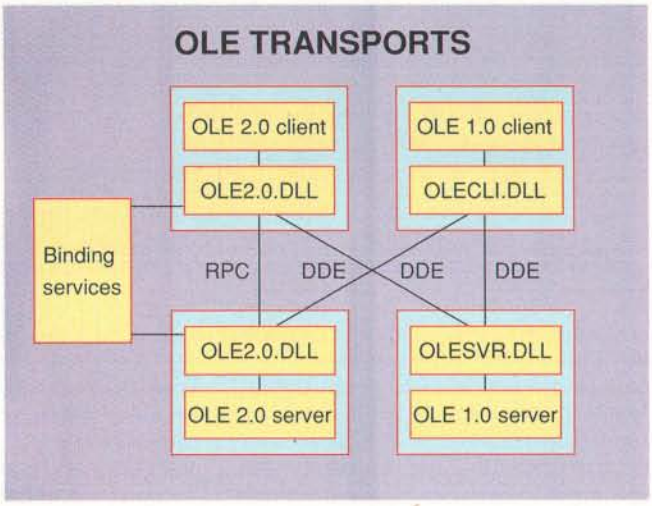


Figure 1: *While OLE 1.0 relies on DDE, OLE 2.0 uses a more robust and sophisticated RPC mechanism to link objects and to enable run-time binding. OLE 2.0 will also support DDE links to ensure compatibility with OLE 1.0.*

them back to the word processor. The word processor would then draw them over the table. Thus, you could edit the table in the document and use all the functionality of Excel.

OLE also provides hooks so that documents can be edited by different objects if the appropriate application isn't handy. Lotus 1-2-3, for instance, could take the place of Excel, even if Excel created the table in the first place.

Microsoft has also been planning for the time when everything is interconnected. Version 2.0 of OLE will be built on top of a more sophisticated Unix-like exchange mechanism called RPC (remote procedure call) (see figure 1). OLE 2.0 also includes a system for handling free-roaming objects by attaching a unique name to each of them. The application will ask for the object by name, and the system will find it. Even if these objects lie in another state, OLE will contain the hooks for finding the correct network connections and obtaining access to the objects—whatever is necessary to get the job done, such as dialing up Prodigy and downloading a file.

Architectural Considerations

Up jumps the problem of heterogeneous networks. What happens when there are different machines from different manufacturers on the same network? Connecting two applications from Microsoft that run on a PC is something that's just starting to happen. How long will it be before all computers can speak to each other?

Although DEC has never been a big player in the microcomputer environment, it is moving to address this issue with its ACA (Applications Control Architecture), CDA (Compound Document Architecture), and DDIF (Digital Document Interchange Format). These are elements of the object-oriented world that allow applications to communicate with each other and with bundle files from multiple sources. The only conceptual difference between ACA and OLE is that ACA will run on multiple architectures.

The process of getting a standard accepted for multiple machines may be difficult, but here's another case where object-oriented software proves its worth. Windows applications running on a PC won't need to be modified to handle both OLE and ACA. ACA will translate its messages intended for Windows machines into OLE requests. The programmers need choose only one standard for the machine and work with it.

The translation functions, however, will work only when both ACA and OLE share the same features. There must still be something that all the applications agree on. The DDIF is intended to provide this commonality by prescribing a format for all documents.

Microsoft is already promoting a candidate called RTF (Rich Text Format) and is encouraging all word processor vendors to support it. Some word processing vendors are balking at accepting this proposal, however, because the format is somewhat provincial: It has commands only for features that are supported by Microsoft Word. DEC is attempting to produce a richer language that supports features on all word processors, and it plans to upgrade the standard frequently.

DEC seems to be the first manufacturer with a well-developed multiplatform system, perhaps because the company has such a diverse installed base (i.e., VAXes, R3000-/R4000-based workstations, and PCs). All the other software system developers, however, are planning to develop this type of intermachine management.

OLE, for instance, will run on the Mac. The workstation companies (e.g., Sun Microsystems, HP, and DEC) have joined the Object Management Group to develop a standard for distributed object systems. This group plans to disseminate its standard in the same way the Open Software Foundation has. Its challenge is to come to an agreement on the particulars.

Leveraging NewWave

HP introduced NewWave some years ago as a meta–operating system that would sit on top of Windows and DOS and provide an object-based environment. The data files and applications are primal objects. Thus, you can link them as well as create complicated but versatile scripts. Many of the ideas that are part of the Windows and Mac interfaces were previously incorporated in NewWave.

HP and Sun Microsystems are also building a distributed object management facility that will lie underneath NewWave and allow objects to be shared over a wide range of machines. This system will provide many of the same features that OLE and ACA are planned to offer.

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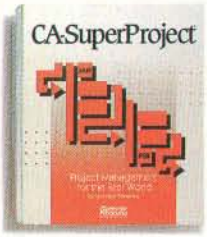

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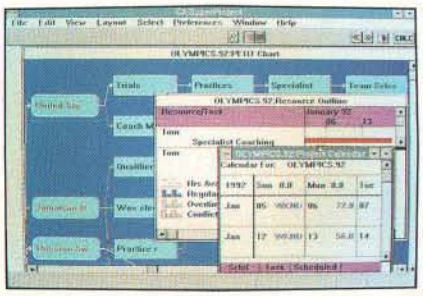

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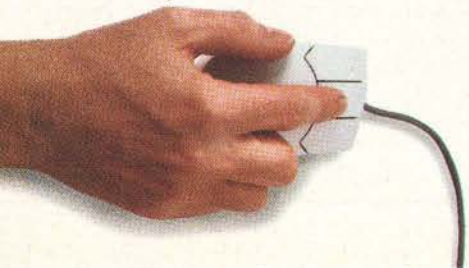

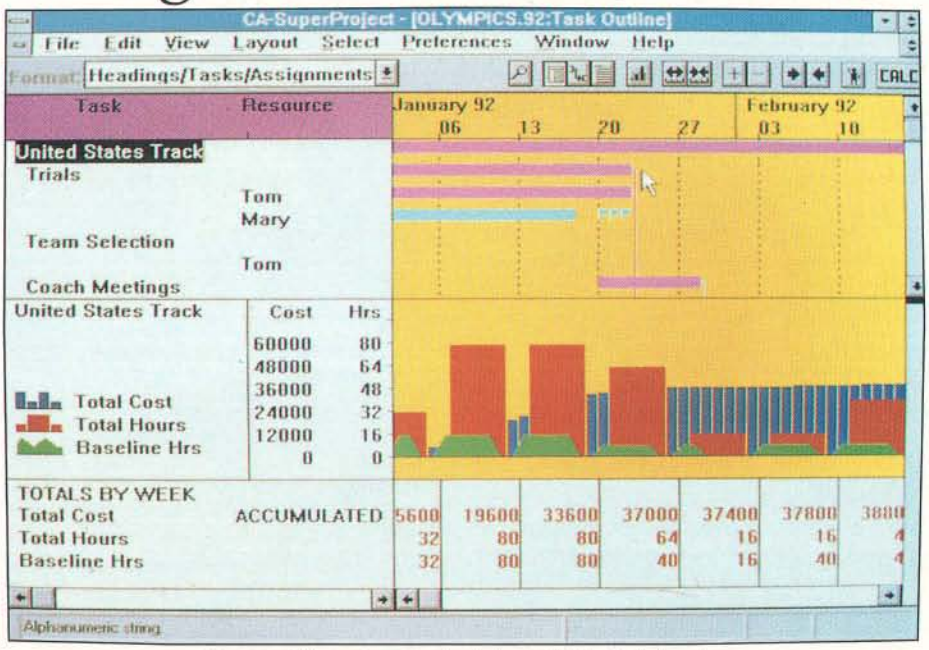

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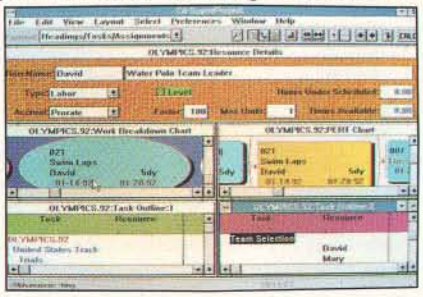

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Objects and PenPoint

MARK CLARKSON

Traditional operating systems force you to distinguish between where data is *stored* and where you *work on it*, and between a *file* and the *application* used to manipulate it. In Go Corp.'s (Foster City, CA) PenPoint operating system, there is no such distinction between these locations—its notebook-metaphor interface is the place where documents are stored and worked on. Likewise, there is no distinction between a file and the application used to manipulate it—there are only documents. The application and the data it's working with merge and become one. You just turn to a page and start to work. PenPoint treats applications as objects; the operating system can stop and start them on demand just by sending messages (see figure A).

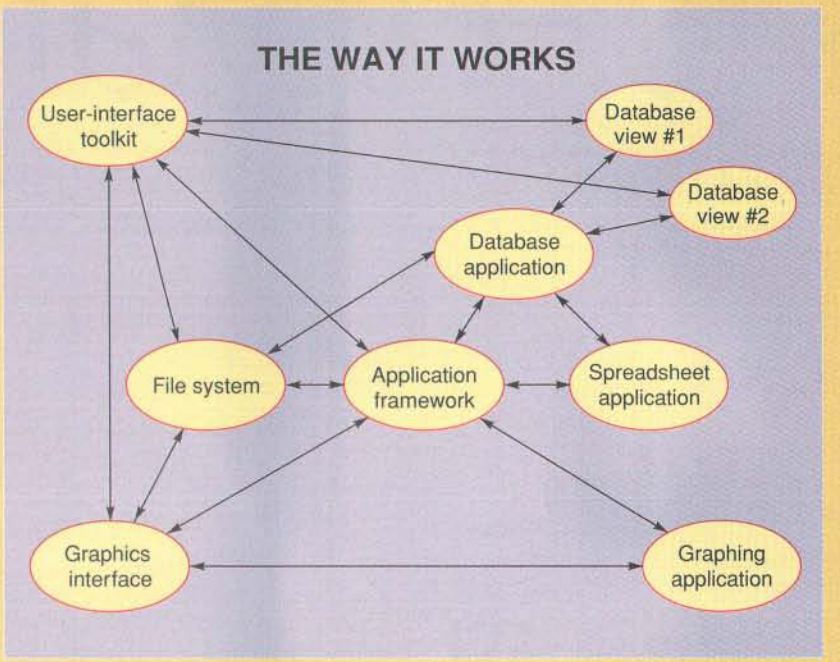


Figure A: *Objects interact with each other by passing messages (represented by arrows). Applications usually communicate with the operating system via the application-framework object. Applications can also communicate directly with operating-system components (e.g., the file system) or with other applications.*

The Inside Story

The most salient object-oriented benefit of PenPoint to both users and applications developers is its EDA (embedded document architecture). Where traditional operating systems support pasting and linking between applications, the EDA allows an application to run inside another (e.g., spreadsheets inside CAD drawings). You can embed graphics into a spreadsheet, even if the two programs come from different vendors. The embedded documents are live: The applications behind them are running; you can manipulate them as you would if you were running them individually.

"It's much better if you can buy smaller, more focused programs that excel at doing the things they do," says Robert Carr, president of Go. "Then, if the operating system can support their working well with each other, you get the best of both worlds."

Jim Poole, vice president of sales and marketing for Ink Development (San Mateo, CA), agrees: "Under PenPoint, you can have applications that have a focused set of features. If you need to add additional features, you can do it through embedding. It allows you to take advantage of what you've purchased and what you've learned."

Ink Development's president, Matt Kursh, foresees in-house applications developers becoming "solution developers." They would integrate components from other vendors into something that to you is a seamless application. For example, a developer could assemble a personal information system from a database, graphics program, calculator, and note taker.

An example of the EDA is the table of contents in a PenPoint Notebook, which displays the names of the documents a Notebook contains and the page numbers on which they are found (see the screen). To open a document, you tap on its icon or its page number with the pen, and the Notebook turns to that page. To remove the document, you turn to the table of contents and cross out the document with the pen.

A developer can also make public the messages its applications respond to so that other developers can tailor their applications to interact more directly with them. But applications needn't pass messages to—or embed in—each other. To keep a spreadsheet handy while you work on a report, you can simply pin the spreadsheet to the report's *cork margin*. That's an area at the bottom of an application window where other applications can be attached, just as notes can be pinned to a bulletin board.

Instant Updates

A *class* is a group of objects that share common behaviors and capabilities. All applications under PenPoint, for instance, are members of the class `clsApp`. Under `clsApp`, there are a number of Pen Magic Software's (North

Vancouver, Canada) Numero products (e.g., Sketch, Graph, and Formula). Specific applications are *subclasses* of `clsApp` (e.g., `clsNumeroSketch`). A subclass inherits all the capabilities of its parent class.

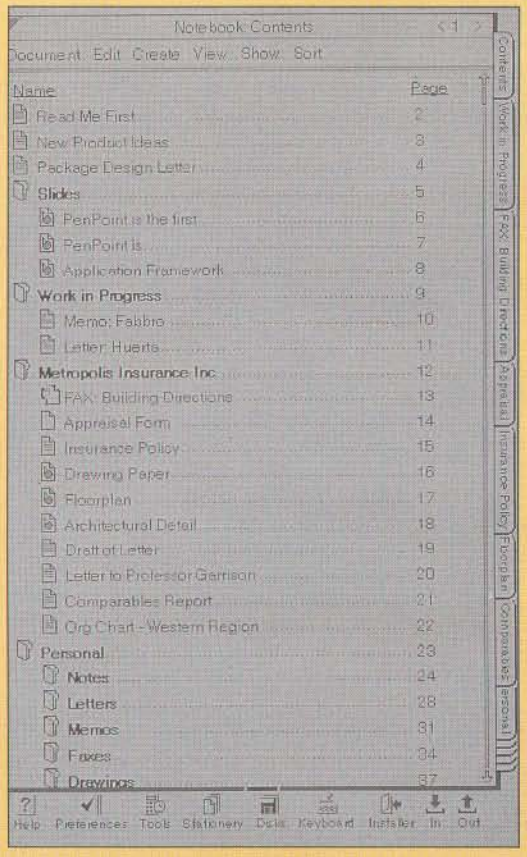
During its development, the appearance of PenPoint—the shape of the buttons, the system font sizes, and the look of the menus—changed constantly, but developers didn't have to do any extra tweaking. Because applications use subclasses of user-interface objects (e.g., buttons and menus) that the operating system provides, the programs automatically conformed to the new defaults, a benefit that resulted in decreased development time.

As PenPoint gains features, so do the applications running on it. For example, Carr says that when Go adds E-mail or voice support to PenPoint, all PenPoint applications will support it instantly, even those already installed.

Recycling Code

Because of its object-oriented design, PenPoint lets developers reuse code, increasing the reliability of new products and shortening the time required before they arrive in the market. Code reuse also results in tremendous consistency and enables applications to occupy less space. Ink Development's NoteTaker and NoteTaker Photo, for example, share 180 KB of code. Because programs share the same code, they seem to occupy the same space. NoteTaker is about 300 KB, and NoteTaker Photo is about 250 KB. But loaded on your system together, they occupy not 550 KB, but only 370 KB.

Breaking programs into independent objects allows them to interact with each other and with the operating system in ways unheard of in conventional operating systems. For example, Numero stores all its financial data in a database object that is active all the time. Many different worksheets can access the database, providing tight linking and updating of data across all the documents.



In the PenPoint Notebook user interface, each icon represents a document that is embedded in the table of contents. These icons—and the documents they represent—can be opened, copied, moved, and deleted with gestures of a pen. The tabs along the right edge let you jump to a specific place in the Notebook, and the bookshelf along the bottom gives you access to common services.

Direct Effects

Object orientation can affect you directly. For example, NoteTaker provides a set of drawing tools (e.g., pencils and erasers) and different colors of ink. To change the attributes of the pen (or any other user-interface object under PenPoint), you can draw a check mark over its icon. An option sheet appears, allowing you to change the pen width, ink color, and shape of the tip.

This is pretty standard stuff. But because this program exists under PenPoint, the pen is an object, and objects can copy themselves. Make a copy of the original pen, select gray ink and a fat tip, and rename it Fat Gray Pen: You've created a new tool. If you don't like the selection of ink colors, you can change or delete them. They're just objects.

Because the operating system already provides for copying objects, displaying their icons, and changing their labels, the drawing program inherits this power. You inherit the power to manipulate these applications in ways that would be difficult to achieve under traditional operating systems. Entire documents can be manipulated the same way as other objects in PenPoint. You can insert a live document into a paragraph of your PenPoint word processor as easily as you can insert a word into a paragraph in a traditional word processor. This is the essence of an object-oriented operating system.

Mark Clarkson is a freelance science writer living in Wichita, Kansas. You can reach him on BIX c/o "editors."

Object-Oriented CASE

DANIEL W. RASMUS

Our rapport with computers has steadily evolved, from switches to machine code to assembly language to third- and fourth-generation languages. Now we have CASE, which was supposed to help nonprogrammers design and, eventually, implement complex software projects. But this promise remains unfulfilled, because the chasm between a CASE model and a program is often unbridgeable.

Objects help. OOP (object-oriented programming) represents the real world in a less abstract way than relational databases or conventional languages. Rather than partition the world into computerized chunks, objects create organic representations. More important, the objects you design in the analysis stage of a project directly correlate to the objects you implement in code.

Objects already provide support for heterogeneous development and a tight coupling between the data and the process. Object CASE represents a movement beyond simple thinking and organizational tools. The future of CASE should include a clear connection between business rules, data and processes, and the systems they buttress.

CASE support for objects is sparse, and where it does exist, it follows older CASE tools down the drawing path and away from the touchy issues of implementation and testing. Many methodologies exist to support OOP, but they usually stop at the analysis stage. At Object World 1992 in San Francisco, the first glimmers of something better arrived.

Merging CASE with Objects

IntelliCorp (Mountain View, CA), the granddaddy of AI companies, has struck two deals that will influence the future of CASE. The first integrates the Prokappa client/server development environment with KnowledgeWare's ADW (Application Development Workbench) CASE tool. That connection translates ADW Entity Relationships models, associations, and properties into Prokappa object relationships, attributes, and facets.

The imported objects are immediately ready to implement Prokappa programs through high-level programming and graphical interface tools. Thus, the abstract becomes concrete.

James Martin, one of the KnowledgeWare founders, created the second deal through James Martin & Co. This agreement will support IntelliCorp's development of new CASE tools to support Martin's Object-Oriented Planning and Analysis and Enterprise Engineering methods. By creating object-oriented CASE tools, information engineering practitioners can quickly simulate the results of analysis and implement production-quality code in one environment.

Object-oriented CASE does not eliminate the thinking part of systems development. It may, however, reflect the first steps toward CASE tools that let end users create complex software systems.

Daniel W. Rasmus is a freelance writer specializing in technology topics. You can reach him on BIX as "drasmus."

The Rosy Future

For both the Mac and the IBM-compatible worlds of Windows and OS/2, good IAC mechanisms have been announced or installed. The real future, though, lies in the shift to object-oriented technology, which is just a stepping stone to greater advances.

Apple is sure to include more voice-recognition technology in future versions of its operating system. The company is also preannouncing several of its coming Newton Personal Digital Assistants. And Microsoft is developing a version of Windows for pen interfaces. Many other technologies are bound to be developed that will change how you work with data.

Object-oriented systems are the foundation of a significant shift. Developers used to assume that they had control of the machine, and this inertia slowed change. Today, you can hook up a voice-recognition system to your machine, but most software still can't take advantage of it.

The object-oriented environment brings into being user interfaces and applications that will come in separate layers. The interface layer might send its drawing commands off to a 3-D virtual reality rendering system that receives all its commands from subdermal neural contacts. System software like OLE or Apple events will carry the messages back and forth between the two layers. As a result, you will be able to customize everything—you'll be able to mix and match to your heart's content.

In addition, object-based technology could also make it easier to automate the design and production of complex software systems. The marriage of object technology and other software-engineering technologies (e.g., CASE) could make it much easier to develop high-end business software systems (see the text box "Object-Oriented CASE" above).

Grains of Salt and Sand

The problem with buzzwords like *plastics* or *objects* is that they represent an ideal. Much work still lies between the dream and a disk filled with object-oriented software. Many programmers need to rework their software to take advantage of the new object hooks. And you'll need to ask for these features and learn how to use them. Before you can begin this journey, however, the world must agree on a standard. Programmers aren't likely to put much work into developing the necessary hooks until they're sure that it will pay off.

Political battles remain to be fought. DEC's ACA talks to Microsoft's OLE, but many differences still exist between any two versions of an object-oriented operating system. Objects will resolve these issues more easily, but the dust won't settle for a long time to come. When the fray's over, your desktop will be different from the one you have today. ■

Peter Wayner is a consulting editor for BYTE. You can contact him on BIX as "pwayner."

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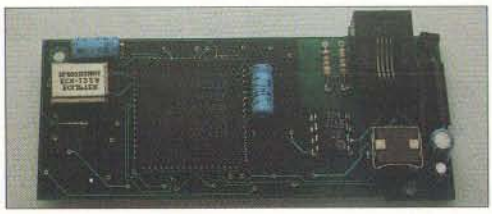

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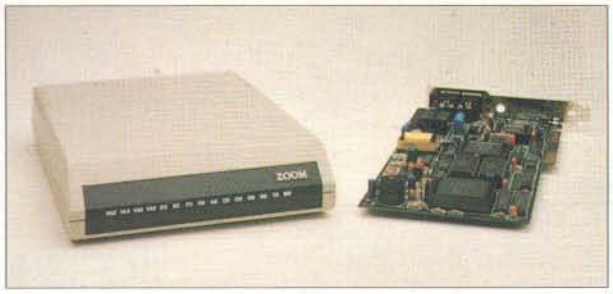

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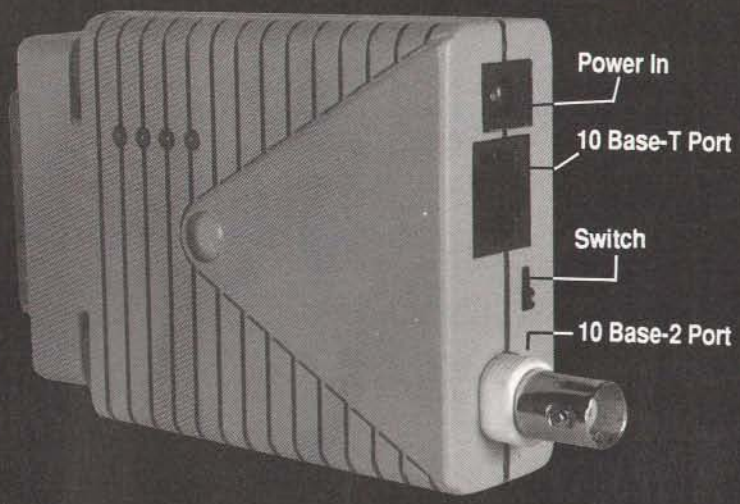

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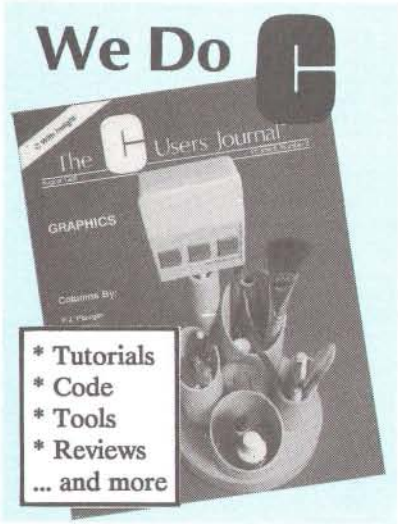

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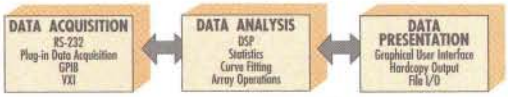

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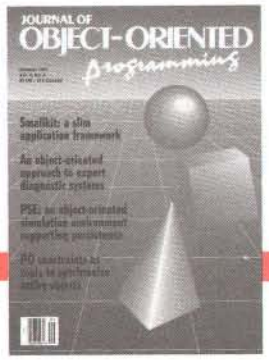

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RELATING TO OBJECTS

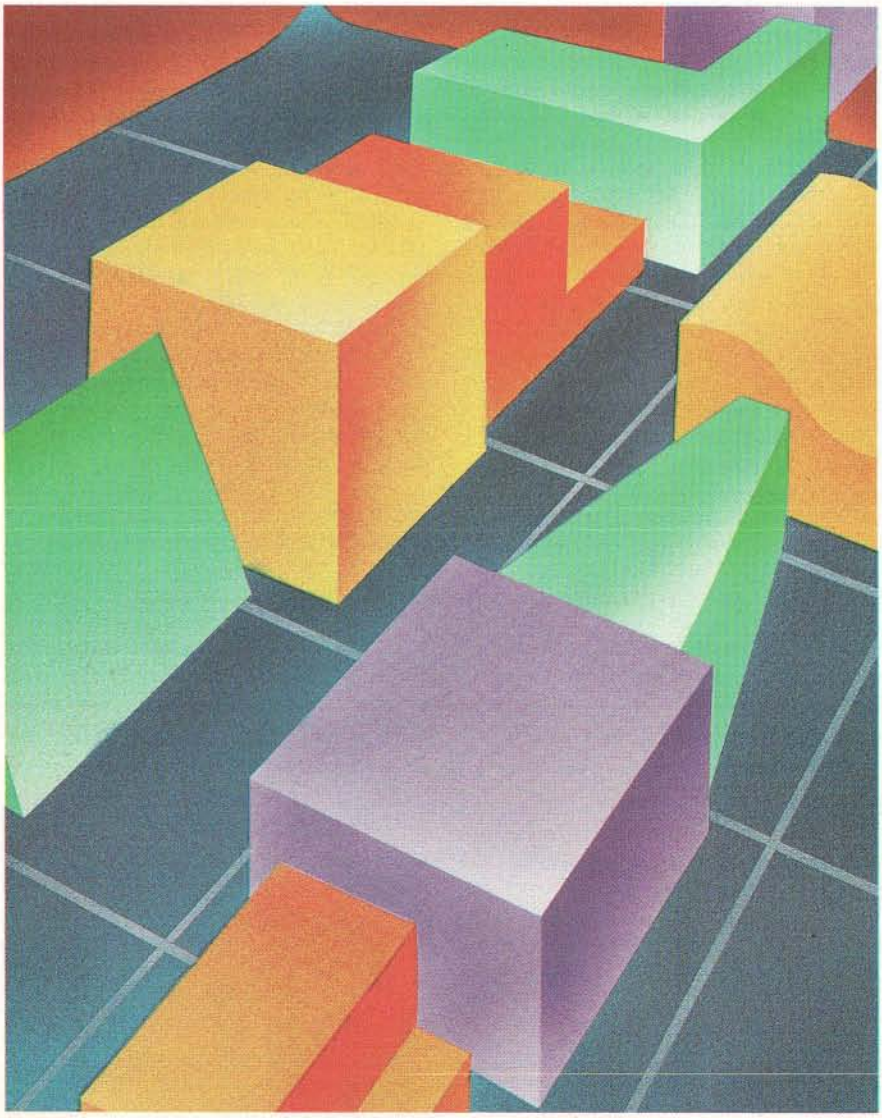
Object technology is supplementing and supplanting traditional relational DBMSes for some database applications

DANIEL W. RASMUS

The traditional database notion of storing data in two-dimensional tables or in flat files breaks down quickly in the face of the complex data structures and data types used in applications such as CAD and multimedia. For example, a contact's name and company are easily expressed in tabular form. However, the design of a new product or the factory that builds it can't be expressed so neatly in tuples and relations.

OODBMSes (object-oriented database management systems) are designed for use in areas such as manufacturing, document management, engineering, and software development (see the text box "Object Databases Find Their Niche" on page 164). All these areas use data types not easily manipulated with conventional databases. Easily shareable versions of product designs—complete with structures, simulations, schematics, and other complex data—are difficult to realize without a common object metaphor. In fact, some business data (e.g., bills of material) translates better into objects than into tuples.

In software engineering, many companies are expected to follow the lead of Next, which hopes to make its development environment more robust by storing its graphical objects in an OODBMS. That will make the objects persistent and reusable and allow easy tracking of versions and implementations.



A Database Is a Database

OODBMSes do everything required of a database and add innovative elements of their own. They provide the same functions (e.g., persistence, concurrency, recovery from hardware and software faults, and support for ad hoc queries) as do

ILLUSTRATION: BOB SCOTT © 1992

standard databases.

The important difference between an OODBMS and a RDBMS (relational database management system) is the basic data model. RDBMSes are derived from strict mathematical concepts, whereas object-oriented databases have evolved from semantic databases and other more touchy-feely disciplines. Thus, object-oriented databases have less of a standard theoretical underpinning than relational databases and differ more from implementation to implementation.

An Object Is an Object

Besides being good members of the database community, OODBMSes must be good members of the object-oriented community. An OODBMS consists of a data model for persistent objects that inherits its basic structure from nonpersistent OOP (object-oriented programming) languages. In addition, OODBMSes must support the basic features of object-oriented languages (e.g., classes and inheritance).

The principal differentiator between OODBMS and OOP languages is the persistence of the objects. With an OODBMS, the objects remain when you turn off your computer or leave an application. In most OOP systems, the results of an application may end up in an RDBMS or a flat file, but the objects—and their complex relationships and activities—cease to exist when the last electron scoots through the CPU.

With their persistence, OODBMSes allow long-term storage of complex objects, such as compound documents, computer network simulations, or models of DNA. The objects remain intact from session to session, eliminating the necessity of piecing together models from a hundred joins, as you do in the relational realm.

Configuration and History

An important difference between relational databases and object-oriented databases is in the creation of new versions of data. When an RDBMS creates a new table from an existing one, it does not maintain a relationship between the previous table and the new one. In an object-oriented environment, however, you can always trace the family history of a class of objects. Even if all attribute similarities disappear between the parent and the child, you can always see the historical linkage.

This configuration management capability works well for system developers, but it's even more important for end users. Manufacturing people and engineers need to know about the different versions of objects they are working with. Keeping track of various configurations in a relational database requires some touchy programming: You must keep track of several tables and keys, and the information contained in these configurations is complex and linked to several other pieces of complex information, such as drawings.

In the OODBMS answer to this problem, different configurations exist as subclasses of an original configuration. In a conventional relational world, tracking the history of real-world or software objects falls within the purview of the application program; with object-oriented databases, objects maintain their own versions.

Relationships and Transactions

Object-oriented languages support two basic relationship concepts: IS-A and PART-OF. IS-A relationships indicate that an object is a kind of something (e.g., a football is a kind of ball). The PART-OF relationship indicates that an element is part of something (e.g., a tire is part of a bicycle).

OODBMSes go beyond these basic relationships to include complex notions like OWNS or LIVES-IN. Inverse relationships also exist in an OODBMS. A car bumper, for example, exists as a thing that is part of a car, and the bumper object has a slot that stores the type of car it is part of (the PARENT relationship). The synchronization of inverse relationships and other relationships causes potential difficulties with referential integrity. Each object-oriented database implements its own relationships and integrity semantics.

Another area where object-oriented databases differ from relational systems is in their support for cooperative transactions, which include long transactions and nested transactions. A *long transaction*, for example, might be one that allows multiple reviewers to add their comments to a single document. A *nested transaction* might take place on a bill-of-material file that is made up of lower-level subassemblies. Even though the transaction would need completion before commitment, lower-level subassemblies that don't create contention could be committed before the main transaction. Many OODBMS products implement soft locks, which notify the initiator of a violated lock. Just as with other enhancements made by OODBMS products, cooperative transactions make it possible for developers to create new classes of applications through embedded capability rather than through application-level trickery.

OODBMSes also present new issues for the security-minded. Instead of control over tables and database sets, OODBMS practitioners must concern themselves with authorized access to classes, instances of classes, and methods.

Object-oriented databases must be able to be integrated into a relational world.

The OODBMS Difference

- Manages complex data types
- Supports OOP concepts (e.g., inheritance and polymorphism)
- Handles cooperative transactions
- Allows distributed applications

Fitting In

Relational databases will continue to dominate the market for the foreseeable future, with object-oriented applications developing in areas not strongly supported by relational systems. Thus, to prove useful, object-oriented databases must be able to be integrated into a relational world.

There are two ways to deal with the relational world when you are using objects: interfacing and encapsulation. *Interfacing* requires no new magic, just detailed instructions that link object systems with relational systems.

In *encapsulation*, object-oriented databases play the role of information brokers, and the relational database becomes an abstract data definition. By encapsulating a relational database and transforming its access into methods, developers and end users would see only the object-level interfaces rather than the syntax and semantics of differing databases.

What's Missing

Commercial acceptability of object-oriented databases hinges on vendor independence, transportability, and investment insurance. If you buy Oracle and something happens to the company, you can, with relatively little effort, transport your data to another relational database product.

continued

A PC Is A Terrible Thing To Waste.

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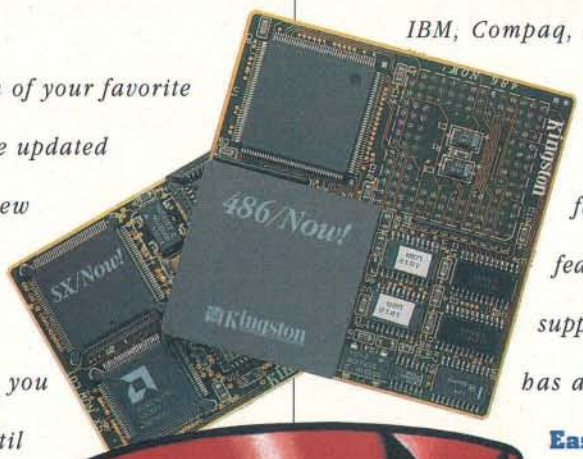

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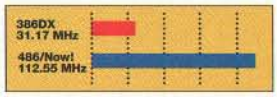

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Object Databases Find Their Niche

OODBMSes (object-oriented database management systems) do not have a wide following. As yet, no standards have been written for them, and no one implementation runs on more than a handful of platforms. OODBMSes, however, are making their presence felt. Their ability to capture complex data and relationships makes them ideal for engineering, manufacturing, and document management projects. Many of these disciplines now use custom databases or none at all.

OODBMSes are having a great impact on the engineering community. People who must deal with requirements for engineering data management and product data exchange find object-oriented databases a desirable alternative to older database technologies.

Mozaic, from Auto-trol Technology (Denver, CO), uses Object Design's (Burlington, MA) ObjectStore to implement a data structure compliant with STEP (Standard for Exchange of Product Model Data) to capture complex information about parts and assemblies. STEP goes beyond previous standards like IGES, which only represent geometric data, and includes information about versions, tolerance specifications, surface finish, definitions, geometry, and topology. Several other companies, including STEP Tools (Troy, NY) and DEC (Maynard, MA), are using object-oriented databases to accomplish STEP compliance.

Not every firm needs STEP. One of the earliest adopters of object-oriented databases was Computervision (Bedford, MA). At that time, the company's developers wrote most of its CADD product with C++. From that experience, they realized that their next-generation CAD systems needed object-oriented databases. Computervision undertook a 50-person-month effort to evaluate object-oriented database technologies.

The evaluation team set aggressive goals. They wanted to be able to select 100 objects from a three-level hierarchy of 1 million objects in less than 2 seconds. The database also needed to provide fast vector calculations and to be able to support large structures.

Estimates of structure size ran from 1000 to 100,000 objects. Every design would contain several versions, each with from 0.5 to 5 MB in storage. The team estimated a design history would consume between 10 and 1000 GB. No available relational database was able to handle the complexity of that data with volumes that large and still maintain acceptable performance.

After undertaking extensive tests, Computervision chose a partnership with Object Design. Because Object Design's ObjectStore interfaces directly with C++, the benchmarking team had to modify only 64 lines of code (out of 6223) and add 69 more. OODBMSes had more than proven their worth to Computervision.

Wisdom Systems (Pepper Pike, OH) recently teamed with Itasca Systems (Minneapolis, MN) to integrate its Concept Modeller intelligent CAD system with the Itasca object-oriented database. Concept Modeller's Lisp-based design aids help put manufacturability checks and design-synthesis tools on the engineering desktop, where they can improve quality long before products are manufactured.

The combined product, called Questa:Base, implements several advanced features. They include fully distributed, multiclient, multiserver architecture; two-phased commits and pessimistic locking for data integrity; and site schemas to improve performance.

Manufacturing Objects

The MKS (Manufacturing Knowledge System) from Enterprise Integration Technologies (Palo Alto, CA) integrates process design, equipment engineering, plant management, facilities engineering, diagnosis, monitoring, and control with simulation and scheduling. MKS targets wafer-fabrication facilities but can be modified to handle other manufacturing environments.

MKS was always object-oriented, but its objects were the transient objects of run-time Lisp (i.e., they disappear after the machine shuts down).

This is not true with object-oriented databases; the differences between implementations are profound.

The lack of a common query model also prevents object-oriented databases from being more than niche players. The clean semantics of SQL (Structured Query Language) make it a good way for users to input and query alphanumeric data, which is easily stored in tables. SQL does have its complex side, but because the language is stable and standard, automated tools can help end users navigate these intricacies.

Most OODBMS products don't support query languages outside of C, C++, or Lisp. All the major developers are working on tools for development, but these will also lack standards. You will not be able to translate your knowledge about ObjectStore to an Objectivity/DB database in the near future. Significant differences in semantics and syntax preclude the portability of both data and knowledge.

The Object Management Group, an industry standards body based in Framingham, Massachusetts, is working on solutions to this problem with specifications like the ORB (object request broker). This suggested standard does not detail the development portion of an OODBMS, but it does dictate how objects communicate with each other. If ObjectStore and Objectivity/DB databases exist in the same distributed environment and are ORB-compliant, they will be able to exchange information with each other regardless of their development peculiarities. Query syntax, data definition, communication, security, and other issues require standards

Enterprise Integration Technologies recently started exploring the implementation of Objectivity's (Menlo Park, CA) database, Objectivity/DB, as a supporting object structure for representing the machines, parts, and processes that make up a wafer-fabrication plant.

Texas Instruments went it alone in its effort to build a wafer-fabrication computer-integrated manufacturing system, but its people still saw object-oriented databases as a key technology. TI uses Servio's (Alameda, CA) Smalltalk-based GemStone database. Along with GemStone, TI also uses Geode, Servio's applications development environment, so that end users can easily develop custom queries and reports from the active GemStone database.

Managing Complexity

At Goodyear Tire and Rubber (Akron, OH), Itasca's database is helping manage the resources of entire networks of computers. Taken individually, active user files on a single system are easy to manage. But operators start losing track of files on floppy disks or file servers.

Goodyear's network patrons submit files to the Itasca database through a transparent RPC (remote procedure call). The database keeps track of file locations and histories. Goodyear uses a combination of hard disks, optical disks, and CD ROMs to store the data. Itasca indexes every file on the heterogeneous network.

The problem at Cold Spring Harbor Laboratory, a privately funded research facility on Long Island, New York, isn't old files but capturing the complexity of DNA. As a member of the Human Genome Project, Cold Spring Harbor Laboratory must track and analyze thousands of DNA sequences. Using GemStone, the laboratory's scientists can capture linear DNA sequences in 3-D representations.

Another GemStone application, a medical database called Helios, is scheduled to manage the medical data of patients in the EEC (European Economic Community). The result of an ESPIRIT/AIM Program consortium that includes Hôpital Broussais (Paris, France), the German Center for Cancer Research (Heidelberg, Germany), and the Geneva University State Hospital (Geneva, Switzerland), Helios handles multimedia medical information—from MRI (magnetic resonance imaging) and x-ray results to admission records. It will eventually be used to integrate medical records throughout Europe as part of the EEC Ward Information System.

And there are other object-oriented database applications. These include Bellcore's (Livingston, NJ) Geographic Information System, Obsidian Technologies' Document Management System, and the National Oceanic and Atmospheric Administration's (Rockville, MD) nautical and aeronautical chart system.

The Future of Persistent Objects

Object-oriented databases are ideal tools for representing complex real-world entities and the relationships between such entities on a computer. Unlike relational databases, the elements in an object-oriented database remain whole, and the associations explicit.

Ovum, a British market research firm, forecasts that the OODBMS market and products will mature by 1995, as MIS shops adopt the technology and vendors see returns on their capital. Ovum estimates that by that time the world OODBMS market will reach $560 million, or 7 percent of all DBMS. According to Ovum, by 1995, Extended RDBMS models that include object characteristics or can integrate with object systems will account for $4.2 billion, or 52 percent of the DBMS market.

Engineering will continue to be a primary driver of OODBMSes. Many other disciplines will also put persistent objects to use as they discover the flexibility and organic representations some object-oriented systems allow. Don't expect to see crowds of companies rushing to convert their accounts-payable systems to objects. But the idea of coupling data with process will lead companies to new ways of bringing software applications into the realm of persistent objects.

before object-oriented databases gain the same kind of respect their relational counterparts enjoy.

The Vision Thing

There is a misconception that object-oriented databases should represent only physical things (e.g., compound documents, engineering designs, or DNA models). These databases are as capable as any database at capturing lofty abstract notions or at storing mundane information, such as people's phone numbers.

Phone numbers do not invoke complexity, but they relate to complex things: people and places. The narrow view of objects focuses on complex things not easily handled by relational databases, yet OODBMSes can represent both traditional data and more complex data.

OODBMSes will not overtake the relational model any time soon. Like all technologies, the keepers of the purse strings must examine their investments wisely and only build object-oriented databases where the solution calls for it. Standards do not exist yet for OODBMSes, and it helps if you are C++ for CLOS (Common Lisp Object System) literate. But object-oriented databases can make your life easier in a number of application areas. ■

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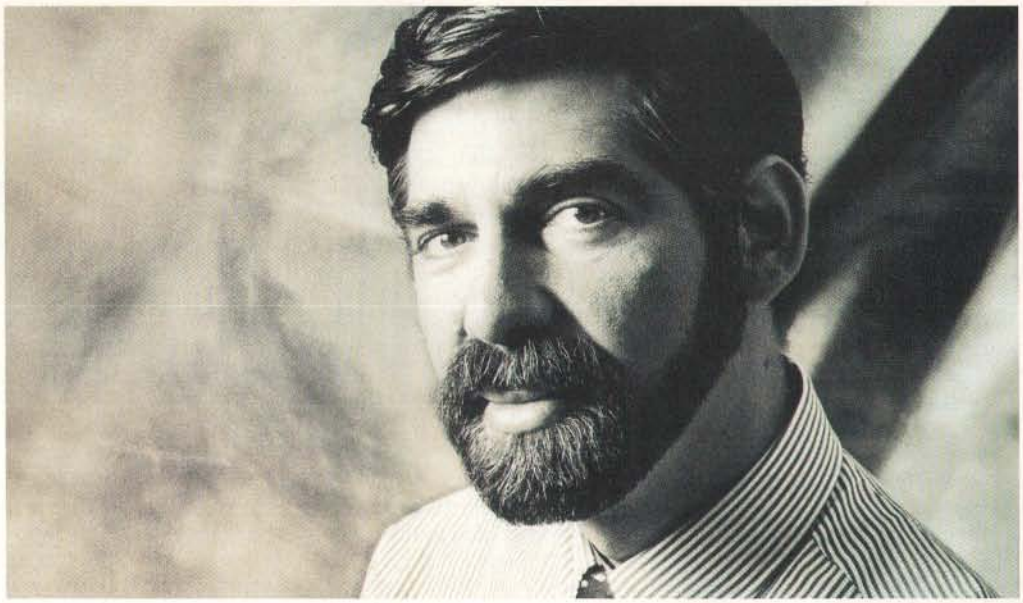

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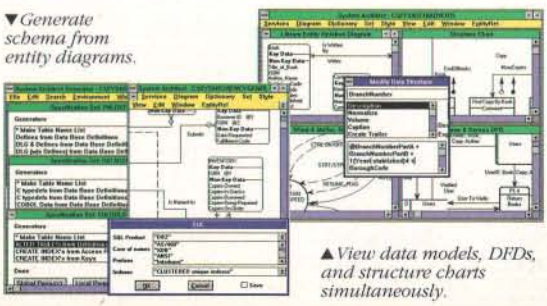

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OBJECTS OF SUBSTANCE

Persistent-data servers provide a new way to store object-based data

SERGIU S. SIMMEL AND IVAN GODARD

One criticism often made of software objects is that they are transient. An object is defined, manipulated, and destroyed by the program that creates it. It has no existence beyond the program. Unlike real-world objects or computer-generated data that exists outside of a program in a file system or a database system, software objects are not persistent. The only way one program can share an object it creates with another program is for the two programs to be executing at the same time. This requirement puts a crimp in any plans for developing distributed object systems.

OODBMSes (object-oriented database management systems) provide one means of giving objects persistence; file systems provide another. Neither solution, however, is ideal for all applications, situations, and implementations. That's the rationale behind a new class of storage software called *persistent-data servers*.

Hobson's Choice

The simplest persistent-data storage available is the file system of your hard disk. File systems have attractive characteristics: They perform well, can hold any data, are easy to use, and are most affordable. Conversely, files are unreliable. They provide no mechanisms for maintaining data consistency and afford only primitive data-sharing facilities. Few file systems offer version control, and all require you to transform data whenever you move it between internal and external forms.

Unlike a file system, a true DBMS provides mechanisms for sharing data and for ensuring its integrity. A DBMS supports transactions and version control, although the specifics of these functions may not

ILLUSTRATION: BOB SCOTT © 1992

be exactly what your application needs. Finally, a database system is scalable and more robust than a file when your hardware or software fails.

The downside to a database system is that it's slower than a file system by an order of magnitude or more. In addition, a database is usually complicated, difficult to learn and use, and expensive in terms of your cost of operation and the amount of system resources it consumes.

Whether you choose a file system or a DBMS, you have to sacrifice either robustness or performance. Is there a happy medium—something with the speed and flexibility of files, the reliability and shareability of databases, a price tag that won't break your wallet, and requirements that your hardware can handle? A new breed of products, persistent-data servers, aims at the yawning gap between DBMSes and file systems.

One Alternative

One persistent-data server that's now available is Penobscot Development's (Arlington, MA) Kala. It's a software subassembly, available to applications and database managers, that manages both the state and visibility of persistent data.

Kala takes care of how data is stored and retrieved as well as where it's stored. It also copes with who can store and retrieve data, which data is available, and when it can be accessed.

Managing State

Like file systems, a persistent-data server offers a get/put interface to the storage subsystem and can store any kind of data. Unlike file systems or the BLOBs (binary large objects) used by some database systems, a persistent-data server lets the stored data retain its internal structure, no matter how complex it is.

Suppose your application builds a linked list in memory and saves the list to a persistent-data store. When you retrieve the data, it will still be a linked list—topologically the same as the original, even though the memory addresses of the nodes are different (see the figure).

Of course, object-oriented databases can also store references, but the links used by the persistent-data server are regular machine pointers, not performance-costly object-oriented pointers. Your stored data can have any representation, including packed structures and executable code. You aren't restricted to a few primitive data types or the type of structures offered by a specific access language. A persistent-data server is as happy storing C++ or COBOL data as it is Lisp, assembly language, or Smalltalk data.

Development Steps

Penobscot Development's Kala provides the persistent-data storage that lets you forget the distinction between in-memory and on-disk data or object formats. You can program using Kala as if your code never had to remember anything across executions or applications. Write your applications as a demo, with dummy data and no storage I/O. You can lay out your data or objects in memory in the way best suited for in-memory-only processing and the fastest execution of your algorithms.

Once you're satisfied with the execution of your demo application, you can think about a production-level persistent-data store for your objects. You first decide what the *unit of transfer* is: which data should go to store and come back as a unit. The ability to choose the transfer unit improves performance because you can bring all the data your application requires at one time. These pieces can be many different objects or parts of objects—Kala doesn't care.

For example, if the data you are using is a linked graph structure, you can either transfer the entire graph in one movement or call each node as you need it. You can also load a graph, excluding the contents of a large but rarely referenced field in each node. And you can bundle the graph with other data or choose another unit of transfer. The transfer unit can consist of bits and pointers spread all over memory.

Using convenient calls to the API, you tell the software where the data is and where, within that data, the machine pointers are. The persistent-data storage software takes care of the rest. It copies the data onto the persistent-data store and gives you a claim check in return. When you present the claim check, the server will promptly retrieve the same data and lay it out in the application memory.

Types Without Limit

Persistent-data servers can handle anything that's made out of bits and pointers. This *model neutrality* makes a persistent-data server an ideal interoperability point in the storage domain. It can reside below all other subassemblies and components that support only a few data organizations.

Persistent-Data Servers

- Maintain the structure of data
- Perform like file systems
- Offer database features

In this respect, the role of a persistent-data server in the storage domain resembles the X Window System in the display domain or PostScript in the printing domain.

For example, an object management system can interpret data as object slots and methods. Because a persistent-data server isn't bound to a particular notion of object, it can simultaneously support several types of objects. The access to and visibility of these objects are guaranteed to remain the same for different language systems, hardware platforms, and object management systems.

Managing Visibility

Conventional DBMSes and file systems treat transactions, access control, security, licensing, version control, and configuration control as separate services. This practice has led to a proliferation of transaction managers, security managers, configuration managers, and so forth. The result is unnecessarily complex, large, and overhead-burdened products.

A persistent-data server can work differently. It recognizes that all the services offered by traditional DBMSes are facets of the same basic problem: controlling the visibility of data.

If you analyze the nature of a *transaction commit* in a conventional database, you find that it is a means of making new values visible to the rest of the world by replacing the old values. Look at *security grants*: They are simply ways of making data accessible (i.e., visible) to qualified agents until access is revoked. You can think of a *license* as a means of making a data set available (visible) to someone on the basis of prepaid rights. And a *configuration* is the bundling of a collection of data so that it is always visible as a unit. Each DBMS has its own idea of how to implement the semantics of these services.

Take transactions, for example. Many useful transaction models exist, because the needs of applications are different. Several useful access control schemes also exist. Security is treated differently in each organization, and the licensing models of information vendors have unique needs of their own. Mathematically, all models are equivalent, because each can be used to implement any of the others. But in practice, this leads to unwarranted complications, overhead, and bulkiness.

Persistent-data software should be different. A persistent-data server like Kala doesn't provide a one-size-fits-all solution for each service. Instead, it provides a handful of primitives that you can use to build the right model for the application. Simple models, typical of conventional DBMSes, are supplied prebuilt.

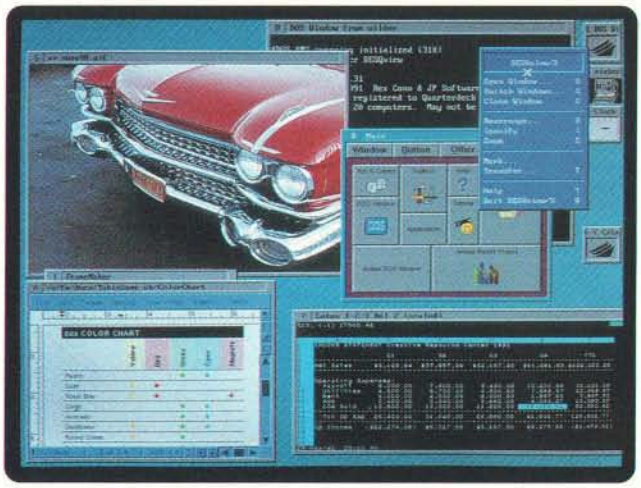
continued

End PC Envy

A Window on the Network

s you can see, DOS programs run alongside Microsoft Windows programs. ou've seen this all before in our DESQview, right? Yes, but now there's more. ESQview/X lets you access and control a ide variety of PCs and workstations rough your own PC. This feature is lled remote computing.

the example to the right, Lotus 1-2-3 is nning in its own 386SX PC. The window top center is a DOS window running on remote 486 PC under DESQview/X. elow left is a FrameMaker file running n a remote IBM RS/6000 workstation in nother part of the company.



Brand and Platform Freedom

ESQview/X runs on 386SX PCs and bove. And from within windows on hose PCs, you can use programs* running n any number of remote DESQview/X Cs if your network supports NetWare or JetBIOS. Add DESQview/X's optional etwork interface for TCP/IP networks and ou can also access programs running on IBM RS/6000s to HP 9000 to Sun vorkstations. And it works the other way, too: these workstations can view nd use DOS and MS-Windows programs in their windows.

*DOS graphics programs currently run only on your local PC.

Works the Way You Want

You can change menus, add sub-menus. Add menu items that run remote programs. Change commands. DESQview/X gives you a menu to use for your macros. And if you prefer a graphical desk top instead of a menu, DESQview/X's Application Manager gives you buttons for opening a set of programs used in a project or even for launching remote programs. What's more, you can specify window size and color. And if you are using DOS text programs, you can set them up so that the font changes size as you change the size of the window. We call this feature scalable DOS windows (see the Lotus 1-2-3 window at the lower right of the screen).

Easy to Set Up and Administer

DESQview/X asks three questions: Do you wish to transfer files to and from other computers? Do you wish to use programs on other computers? and Do you wish other people to have access to programs on your computer? That's all it takes for DESQview/X to set itself up. DESQview/X incorporates QEMM-386 to assure maximum memory utilization and Manifest for easy diagnosis and problem-solving.

Introducing DESQview/X™ for DOS.

Now everyone can access the power of the fastest PC—or workstation—on the network.

DESQview/X literally turns DOS PCs into graphical workstations. With DESQview/X, you can run DOS and Microsoft Windows programs simultaneously, view them in windows, transfer between them, create DESQview/X-global or program macros and manage your files. That makes computing lots easier, more productive, and more fun.

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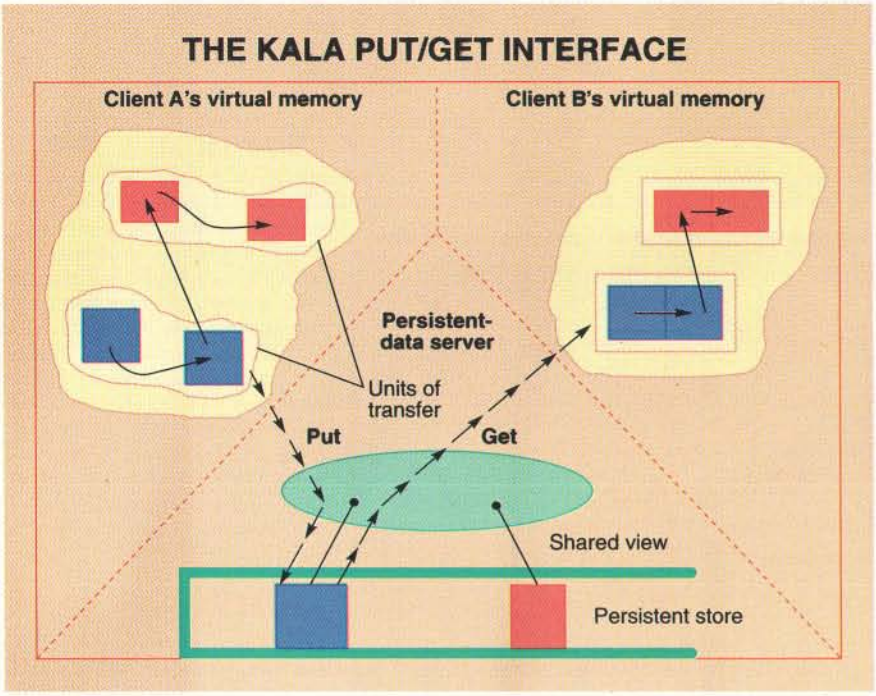

The persistent-data server manages persistence for data of arbitrary bits and pointers. It preserves topological structure on loading the data into memory. It allows control over data's visibility by presenting potentially shared views on data elements in the persistent store.

Managing Performance

The performance of a persistent-data server for a single user is equal to the performance of a good file system when reading and writing the same data. Perhaps surprisingly, its relative performance improves when there are multiple users in a client/server configuration. This phenomenon occurs partly because of the seek optimization and shared buffering of common data used by persistent-data servers and partly because it's not necessary for each application to open and close files.

Kala, for example, is algorithmically faster than equivalent conventional technology exactly when you need it most: at peak server loads. It uses a non-write-in-place strategy, never overwriting a prior value. This particular feature gives it an effective 50 percent update performance advantage in transaction-context applications (e.g., on-line transaction processing). It requires only $1 + 1/n$ disk accesses per update (one to write the new data to free storage and a fraction to record the commit where the commit record is shared with other transactions). A high-performance conventional DBMS must have $2 + 1/n$ disk accesses for the same task (one to write the former value in case of a crash, one to write the new data back over the former value, and a fraction for the commit). This performance gain is not at the expense of data reliability and recoverability.

Persistent-Data Servers vs. Object Databases

Any quality OODBMS can recover all transactions that have been committed, even if they were performed only milliseconds before a crash. Persistent-data servers can do the same, working as fast as less reliable systems (i.e., file systems).

Many conventional OODBMSes, which perform well as single-client applications with systematic access patterns, degrade badly in multiple-client applications, such as groupware, or when used concurrently by different applications that randomly access large pools of data. Many OODBMSes are tuned to display quick response to predictable access patterns. Thus, they often achieve local (i.e., per-client) optimums at the expense of global (i.e., across-client) slowdown.

Some OODBMSes improve object-faulting performance by page-mapping databases using the file-mapping facilities of the operating system. In this instance, the unit of transfer is the fixed-size virtual-memory page (or a multiple of it). These OODBMSes show no sensitivity to the access patterns of the application.

For example, an application may need records scattered throughout a database. In a page-based OODBMS, a 4- or 8-KB page may be brought into memory to get an object that may be only a few hundred bytes. The remainder—perhaps 80 or 90 percent of the total space and access time—is wasted. The OODBMS may be performing well, but the application grinds to a halt due to thrashing in the operating system's page manager.

In contrast, a persistent-data server's user-specified units of transfer should eliminate internal fragmentation. You get only what you requested. In a multiuser environment, this feature also takes care of the severe security loopholes introduced by page-mapping-based approaches, another acute real-world problem.

In conventional systems with single users, you can overcome thrashing and other performance problems by having the user manually cluster the data, relying on the programmer's ability to predict the access patterns of an application and to optimize the database for that application. However, this traditional technique breaks down badly when one application needs one selection of data from the database and a second application, perhaps running concurrently for other users, needs different selections. The result is less-than-optimal global behavior.

Persistent-data servers offer an alternative. Kala, for example, doesn't use such local optimizations. Instead, it uses access history to dynamically rearrange the store so that global optimization occurs. If there is only a single user application, the software should be able to achieve clustering as well as the best manual packing. It also should give globally optimum performance in multiple applications without requiring the services of an expensive database administrator to tune the clustering.

Moving Forward

Persistent-data servers such as Kala provide a new and exciting middle ground between the performance of file systems and the capabilities of database managers. They are particularly useful as the underpinnings of object stores because they maintain the structure of the data on the disk, making it independent of the application that created it.

More and more, applications need access to complex data types, and increasingly, applications must support multiple users in distributed environments. From flat files to objects, persistent-data servers can handle them all. ■

Sergiu S. Simmel and Ivan Godard are the cofounders of Penobscot Development. You can reach them on BIX c/o "editors" or on the Internet at kala@world.std.com.

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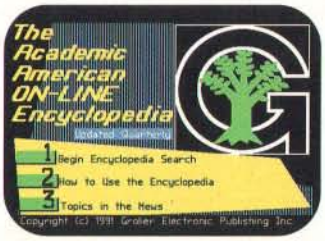

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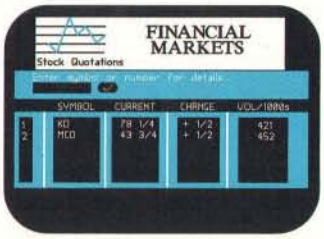

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Object-Oriented Database Managers

At the heart of most corporate information systems—and a good number of smaller ones—is a database system that stores and retrieves information of value to an organization. Most databases installed over the past decade have been of the relational type, but with the increasing importance of complex data types (e.g., those used in multimedia applications) that are not easily handled by relational systems, some organizations are moving toward OODBMSes (object-oriented database management systems) to handle their storage needs. Listed below are some of the major players in the OODBMS market.

GemStone

The GemStone OODBMS is the centerpiece of a complete object-oriented application development environment from Servio. In conjunction with GeODE, Servio's object-oriented rapid development system, GemStone lets you create GUI-based multimedia applications without having to know how to program in C++. GemStone supports a client-server architecture and provides gateways to RDBMSes (relational database management systems).

Servio Corp.
1420 Harbor Bay Pkwy.,
Suite 100
Alameda, CA 94501
(800) 243-9369
(510) 748-9369
fax: (510) 748-6227
Platforms: VAX/VMS, Ultrix, IBM RISC System/6000, Sparcstation, OS/2, Windows, and Macintosh.
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Itasca Distributed Object Database Management System

Itasca is an OODBMS based on the Orion project at Microelectronics Computer and Technology. Itasca features dynamic schema modification, letting users at one site continue to access the database even while modifications are being made to the database schema at another site. Itasca stores its methods with its objects and not in another program space. This permits multilanguage access to the objects. Itasca comes with a complete suite of management utilities.

Itasca Systems, Inc.
7850 Metro Pkwy.
Minneapolis, MN 55425
(612) 851-3155
fax: (612) 851-3157
Platforms: Various workstation systems.
Circle 1156 on Inquiry Card.

Objectivity/DB

Objectivity/DB is designed to support multiuser applications such as ECAD, MCAD, CASE, publishing, and multimedia that are not well supported by RDBMS technology. Objectivity/DB provides interoperability between the many platforms it supports in the form of transparent byte ordering, floating-point representation, and alignment. It features peer-to-peer communications, strong configuration management support, and flexible data modeling.

Objectivity, Inc.
800 El Camino Real
Menlo Park, CA 94025
(415) 688-8000
Platforms: Silicon Graphics Indigo, Ultrix, VAX/VMS, HP 9000, IBM RISC System/6000, Sun-3, and Sparcstation.
Circle 1157 on Inquiry Card.

ObjectStore

ObjectStore is a client-server OODBMS designed to facilitate cooperative workgroup activities and the storage and retrieval of multimedia data types. ObjectStore features single-level storage, which doesn't differentiate between an object in memory and an object on disk.

Object Design
1 New England Executive Park
Burlington, MA 01803
(617) 270-9797
fax: (617) 270-3509
Platforms: Windows 3.x, Sun-4, IBM AIX 3.1, DEC Ultrix 4.1, HP-UX, and Unix System V release 4.0.
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Ontos DB

Ontos DB is a distributed-object database that uses objects throughout the system. It is designed to facilitate workgroup computing; the latest release (2.2) uses high-concurrency object technology that makes it possible for many users to access specific objects simultaneously. Ontos, Inc., supplies a range of development tools for the Ontos DB system.

Ontos, Inc.
3 Burlington Woods
Burlington, MA 01803
(617) 272-7110
fax: (617) 272-8101
Platforms: Sun-4, Sparcstation, SCO Unix, HP-UX, Domain, IBM RISC System/6000, OS/2, and DECstation.
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O^2

Initially designed and developed within the Altair research consortium, O^2 is a client-server OODBMS that provides a complete application development environment. Among the tools that come with the system are a query language, a user-interface generator, an object 4GL (fourth-generation language), and a graphical programming environment.

O^2 Technology
BP 105
78153 Le Chesnay
Cedex, France
Platforms: Various Unix-based workstations.
Circle 1160 on Inquiry Card.

UniSQL/X Database Management System

UniSQL/X is a unified relational and object-oriented DBMS that provides object-oriented data handling in an ANSI SQL (Structured Query Language)–compliant environment. In the UniSQL/X environment, the relational aspects of the system are an instantiation in the object-oriented class hierarchy. The system thus retains relational behavior—and SQL compatibility—while at the same time supporting the rich data types of an OODBMS.

UniSQL, Inc.
9390 Research II, Suite 220
Austin, TX 78759
(512) 343-7297
fax: (512) 343-7383
Platforms: IBM RISC System/6000 under AIX and Sparcstations and compatibles.
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GRAB YOUR AUDIENCE WITH AUDIO

Sound boards and software can jazz up your presentations

TOM YAGER AND
RICK GREHAN

Computers can help with the visual part of a presentation, but don't you often find yourself talking over your visuals as if they were overheads or slides? With just a little more effort, you can also use the computer to grab your audience by its ears. Technology has advanced to the point where it's inexpensive and easy to add audio to business presentations.

In this review, we've assembled 20 audio products for the PC, Macintosh, and Amiga that help you bring sound to your presentations. These products represent three basic categories: sound boards, digital audio editors, and sequencers.

To test these products, we built the audio component of a business presentation. We began with canned MIDI music and digitized production music from Voyetra and Prosonus and added our own CD audio and narration. We also played custom MIDI music into the sequencers we tested. The most important factors for us when evaluating each product were how well it worked, how easy it was to use, and what quality of sound it produced.

Intuitive Software Meets Less Expensive Hardware

You don't have to be a recording engineer to add audio to your presentations. Sampling rates, kHz, MIDI tracks, and time codes may be strange terms for many computer users, but editing programs and sequencers have interfaces that make the job of acquiring and manipulating sounds an approachable task. While some of the packages have interfaces that resemble the control panel of an engineering console, others look very much like an ordinary tape deck. These desktop-studio programs are doing for digital audio what desktop publishing programs did for design and page layout: making a technology accessible to nonexpert users.

Besides intuitive software, the other element bringing digital audio to the masses is less expensive, higher-quality sound boards. You can now buy a board that generates CD-quality sound for less than $500. Combine that with editing and sequencing software and you have everything you need to make your next presentation really sing.

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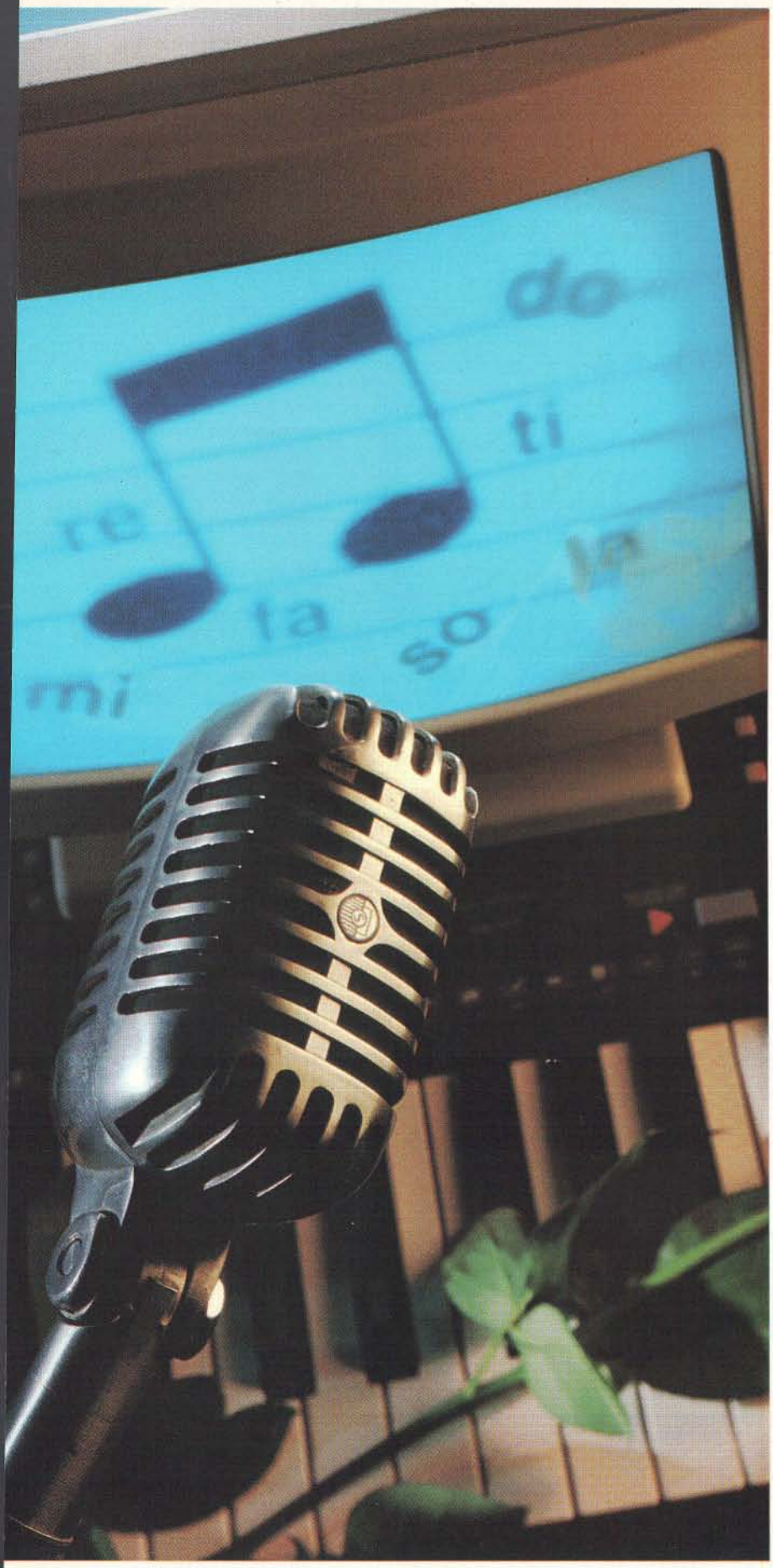

BYTE ACTION SUMMARY

- **WHAT AUDIO PRODUCTS DO**
  Sound boards, editors, and sequencers enable you to produce, record, and edit the audio component of a presentation.

- **LIKES**
  You don't have to be a recording engineer to develop audio for a presentation; sound boards are sounding better and costing less; audio-editing software makes it easy to manipulate sound files.

- **DISLIKES**
  Digital audio consumes vast amounts of disk space.

- **RECOMMENDATIONS**
  Buy a good 16-bit audio board. Turtle Beach Systems' MultiSound, Digidesign's Audiomedia II, and SunRize's AD516 are all excellent choices. In the lower-price category, the Media Vision Pro Audio Spectrum 16 and Roland SCC-1 GS are terrific. Then decide if you need to work with MIDI files, digital audio files, or both. Your source for sound will determine what type of software you need.

It Takes Three to Tango

We'll begin with some details about the three product categories we tested. A digital audio board accepts input from an analog source (e.g., a microphone or a CD player) and turns it into a file that you store on your hard drive. You can then play the file back, with the board turning the digital data back into analog signals that can go to headphones, an amplifier, speakers, or any other device that accepts line-level audio input.

Two factors determine how accurately an audio board reproduces sound: sample rate and resolution. The sample rate, measured in kHz (i.e., thousands of cycles per second), determines how many times per second the sound board samples the incoming audio signal and digitizes it. The higher the sample rate, the better the quality. High sample rates, however, consume lots of disk space. Resolution refers to the number of bits used to store each sample.

Digital audio editors drive the sound boards to capture and play back sound, usually at varying rates and resolutions. They also let you edit the digital data, cutting and pasting it, making it fade in and out, and "overdubbing" one digital audio file on another. It's here that the digital

audio portion of your presentation comes together, so when we looked at the editors, we paid special attention to the quality of the interface.

MIDI sequencers capture and play back music by turning the notes and related events (e.g., presses of the sustain pedal) into a compact stream of digital data. The sound itself is not digitized, just the representation of the notes, so sequencers can adapt MIDI music to change the instruments and the tempo, adjust a note's duration, or even add notes and move notes around.

You don't have to be a musician to use a sequencer. To develop presentations with an audio bang, you need a sequencing package to tailor a piece of music to your particular show. And you don't have to have the composing genius of Duke Ellington: There are lots of prepackaged music files that you can edit with a sequencer to fit your presentation. (For more about sequencers, see the text box "The Advantages of Sequencers" on page 192.)

Most of the sequencers we tested visually resemble a tape recorder. Those that are MIDI only—all the PC sequencers covered here are MIDI only; some audio-and-MIDI sequencers on the Mac are available in MIDI-only form—allow either direct editing of the MIDI data in numeric form or provide some variant of the "piano-roll" representation of notes. This latter technique of displaying data shows notes as rectangles on the screen; time is indicated on the horizontal axis and pitch on the vertical axis, so the display looks like a player-piano roll stretched horizontally across your screen.

The sequencers that can handle both digital audio and MIDI display audio signals as graphical waveforms, with time on the horizontal axis and amplitude on the vertical axis. All sequencers allow you to cut, paste, insert, and delete regions of the waveform much as you would manipulate a graphical image in a paint program.

Synchronization is a critical issue when it comes time to commit your composition to a final tape, particularly if the composition is the sound track to a videotape. You want to make sure that the audio (i.e., music or narration) comes up at the appropriate visual cue. The simplest synchronization mechanism—which all sequencers can receive and many can transmit—is the MIDI time clock (i.e., the timing packets sent down a MIDI cable at regular intervals). A more accurate mechanism is MTC (MIDI Time Code), which is the MIDI equivalent of SMPTE, the Society of Motion Picture and Television Engineers' synchronization mechanism that video systems use to align sound tracks to video frames. SMPTE-to-MTC converters are widely available, and all the sequencers we tested for this review accept MTC synchronization. (See the table for other features of the sequencers we reviewed.)

To test the PC products, we used a Uniq 486/50 EISA cube with 8 MB of memory, running Windows 3.1. We used an Ensoniq EPS 16-Plus sampling keyboard to create and play MIDI music. To test the Amiga products, we used an Amiga 3000T tower system with a 25-MHz 68030, 7 MB of RAM, and an Ensoniq keyboard. We used a Roland SCC-1 GS sound card to test PC and Amiga MIDI sequencers. To test the Mac products, we used a Mac II with 8 MB of RAM running System 7.0. A Roland Sound Canvas and Synth Plus 10 connected via a Passport Designs MIDI interface made up our MIDI test network. A Fostex MN-50 mixer/compressor helped during mix-down when the spaghetti of cables got too thick.

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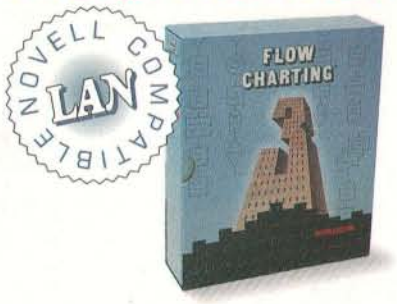

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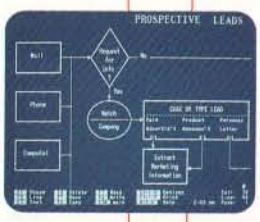

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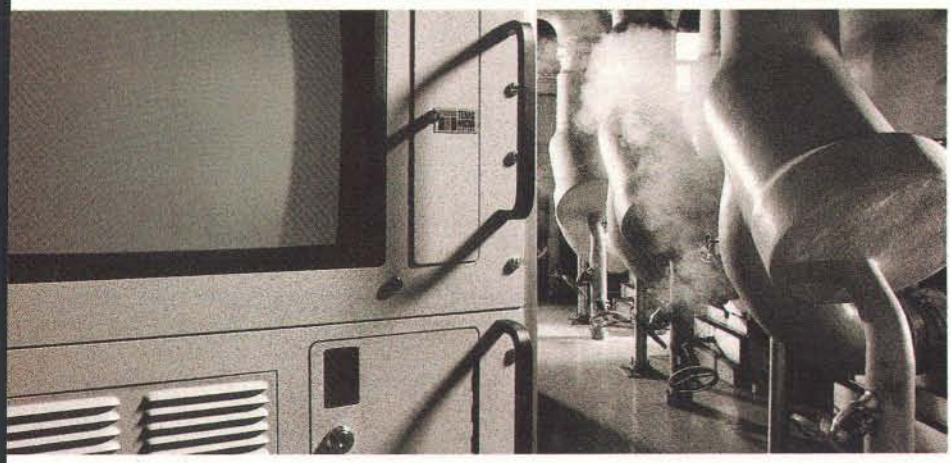

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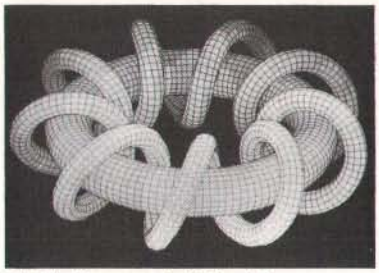

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AUDIO BOARDS

AudioMaster

Omni Labs' AudioMaster is the first board we've seen that adheres to the Media Master Sound Standard developed by Ensoniq (a maker of professional keyboards and musical equipment) to create synthesized music. The Media Master Sound Standard uses a 68008 microprocessor and on-board instrument RAM.

The AudioMaster board uses downloadable wave tables, or short recordings of sounds (e.g., those made by real instruments), as the basis for its synthesis. Not all of the AudioMaster's instruments were sampled from the real thing—Omni Labs took some shortcuts to conserve wavetable memory. But those that were sampled (e.g., drums and piano) sounded authentic enough. The board delivers 24-voice polyphony. The fact that the wave tables reside in RAM means that they can be changed. The AudioMaster board that we tested had no provision for downloading new instruments.

The AudioMaster's digital audio section supports a maximum 44.1-kHz sample rate, with a resolution of 12 bits. Twelve-bit audio is a very noticeable step up from 8-bit. However, 60 seconds of 12-bit audio take up as much disk space as 60 seconds of 16-bit audio.

The AudioMaster is limited to *mono* digitizing, regardless of the sample rate. We don't think that's too limiting (mono recording is a good way to keep files to a reasonable size), but it's certainly a valid point of comparison.

Omni Labs' board comes bundled with a useful selection of software split between DOS (Voyetra's Sequencer Plus Jr. and PG Music's Band in a Box) and Windows (Voyetra's WinDAT digital audio recorder/editor, First Byte's Monologue speech synthesis, and a program for playing audio CDs). The board's software is all installed through an automated program that first checks its ability to communicate with the hardware.

The board's overall quality is good. There is a nondefeatable automatic level control on the digitizing input, which flattens the dynamics of files recorded with it. The digitized audio carries some audible high-frequency noise, and the synthesizer output suffers from noticeable hiss when you hear it played through good headphones or speakers.

Still, we think that the AudioMaster's mostly great-sounding instruments with hiss are preferable to FM synthesizers, no matter how clean. As an inexpensive step up from an 8-bit FM synthesizer–based sound board, the AudioMaster, at $299, is a good choice.

MultiSound

For $599, Turtle Beach Systems' MultiSound board delivers uncompromising quality for both digital audio and synthesized music. The MultiSound's digital audio is among the best: 16-bit stereo at 44.1 kHz. It is a fully MPC-compatible board that can play audio files created elsewhere, and it's capable of recording audio for playback on non-16-bit boards. While the MultiSound's sound is costly in terms of disk space (176.4 KBps of digitized audio), the quality is out of this world. We haven't found a PC board that sounds better than MultiSound.

Music synthesis on the MultiSound is handled by an E-mu Proteus chip, which can produce 32 simultaneous voices from a ROM-based selection of instruments. The chip specializes in realistic-sounding acoustic instruments; its piano, strings, and ensemble horns are very impressive, and the drum sounds are clean, realistic, and hard-hitting.

Compared to other MPC-compatible boards, the MultiSound is sparse on options; except for software (e.g., a Proteus patch librarian and the Wave digital audio editor reviewed elsewhere in this article), there are no available add-ons. The board does have a nine-pin connector for hooking up a MIDI cable, but you can't get Sound Blaster compatibility or a CD-ROM controller. The back panel is simple: ⅛-inch stereo input and output jacks and a recording-volume control knob. Standard software includes a Windows mixer, a diagnostic tool, and a front-panel emulator that lets you adjust the Proteus chip's settings as though you were using a stand-alone MIDI box.

Some might worry that the E-mu Proteus synthesizer chip isn't part of some widely implemented emerging standard, like the Roland GS chip. Standards aren't quite as important here, however, since Windows' MIDI Mapper tends to iron out the differences in instrument assignments between synthesizers. As long as the overall quality of sound is still suitable for professional use (which the MultiSound's E-mu is), adherence to a standard other than General MIDI isn't all that important.

The combination of superclean digital audio with the stunning Proteus synthesizer makes the MultiSound the perfect choice for demanding professional applications. At its newly reduced price, it's an excellent deal.

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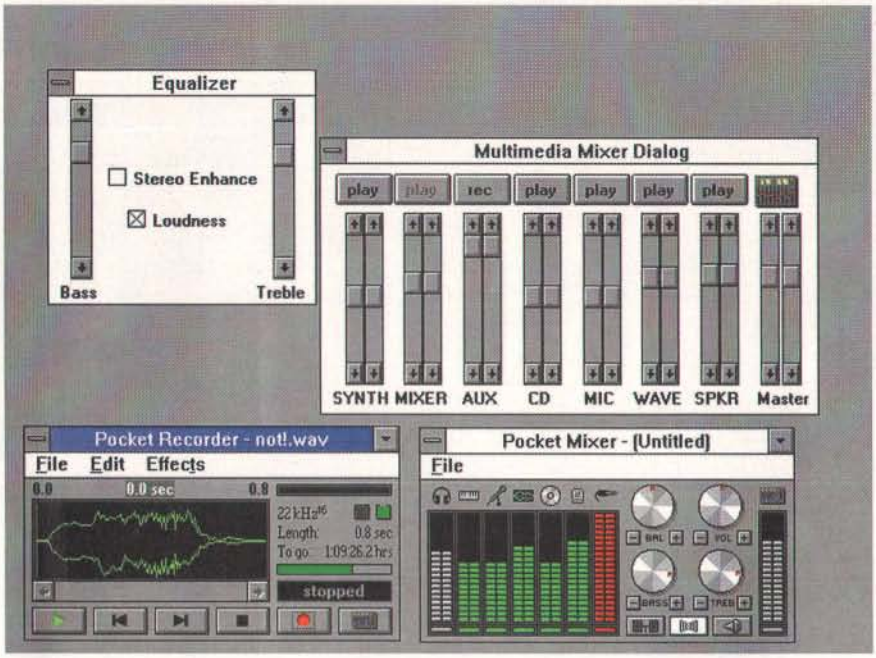

Pro Audio Spectrum 16

This is the best PC sound board in its price range. The $299 board from Media Vision mixes top-quality digital audio (44.1 kHz, in stereo, in 16 bits) with a fitting array of standard software.

Installation is easy, with all the board's options being software-programmable. It has the widest range of IRQ and DMA settings of all the boards tested. A DOS installation program configures and tests the board (and can be used to reconfigure it later). The DOS installation launches Windows, loads the Windows drivers, and creates a program group for all the Windows applications.

A pair of programs, Pocket Recorder and Pocket Mixer, provide quick access to digital audio recording and playback and input-source mixing (see the screen above). Pocket Recorder is just right for a lot of quick digital audio work, and it's a big improvement over the standard Windows Sound Recorder. Pocket Recorder won't let you do cut-and-paste editing, but it does let you record in stereo and set the recording rate and resolution.

Pocket Mixer is a compact, attractively presented control panel from which you set the volume, bass, treble, and balance for each of the Pro Audio Spectrum 16's inputs. You can then save your settings in a file and reload them later.

Media Vision also includes a more capable mixer, through which you can select which audio inputs will be recorded, view sound levels, and switch in loudness and stereo-enhancement filters (the latter fattens the sound with a nice delay effect).

The Pro Audio Spectrum 16 sounds great. Audio digitized at the 44.1-kHz rate and 16-bit resolution plays cleanly, although some hiss becomes evident if you turn the board's master volume up too high. Even quiet digitized musical passages, played through a sensitive amplifier or professional headphones, come through clearly. For a business presentation, the Pro Audio Spectrum 16's digital audio reproduction is impressive, although it's not as good as that of the higher-priced MultiSound.

SCC-1 GS

Roland's $499 SCC-1 GS is a board-level version of the company's knockout Sound Canvas external MIDI synthesizer module. Like the Sound Canvas box, the SCC-1 uses Roland's PCM technology to bring up to 24 simultaneous voices (some instruments use up to two voices) of wonderfully clean music to PCs. What is true of the SCC-1 is also true of the external Sound Canvas module.

The SCC-1's sounds (like those produced by the Proteus chip on the MultiSound) are based on pulse-code modulation, so they are clean and realistic. The acoustic instruments are supplemented with a solid selection of obviously synthetic sounds that provide dreamy backgrounds and rocking leads. In fact, the only thing that places this board a bit behind the MultiSound is the limit on the number of voices. Some of the board's richer sounds, including orchestral sounds and synthesized pads (both used heavily in presentations), use two voices for each note played, cutting the number of simultaneous voices to as few as 12. This might leave you scrambling to find a way to orchestrate your music using as few two-voice sounds as possible. That shouldn't be hard; for most two-voice sounds, there are suitable one-voice alternatives, and staple instruments (e.g., acoustic piano and drums) are done with one voice.

Polyphony limits aside, the SCC-1's sound is very clean and professional, realistic when it needs to be, and worthy of inclusion in your most important presentations. The on-board effects give the SCC-1 a slight edge over other synthesizer boards. The effects are simple—chorus and reverb—but they can have a dramatic impact on the perceived quality of your music.

This board is MIDI only; it has no digital audio or CD-ROM controller capabilities. In a typical Windows setup, you must route the output of the SCC-1 to the auxiliary input of your digital audio board and use the board's mixer application to bring the SCC-1's signal through.

You can use the SCC-1 to replace the FM synthesizer included on so many Windows sound boards. The improvement in quality is significant.

SoundStudio

Cardinal Technologies' $269 SoundStudio was the most difficult of the tested boards to configure and install, and it produced what our ears judged to be the poorest-quality sound. The board itself is loaded with settings; nothing is software-configured. Software installation is straightforward, but if the board's factory-supplied settings aren't right, expect to have some trouble, both with the poor documentation and the necessary yank-adjust-replace-test cycle. To its credit, the SoundStudio comes with MIDI cables and drivers for the on-board SCSI CD-ROM controller; these are typically options with other boards.

SoundStudio's software bundle is supplied entirely (except for the SCSI driver) by Voyetra, and the Windows software includes only the WinDAT digital audio editor, a "jukebox" MIDI/audio-file player, and a mixer. The board is capable of recording in stereo at 44.1 kHz (with a resolution of 12 bits), but the supplied WinDAT was only willing to record up to 22 kHz. Wave for Windows drove the board at its highest rate, but regardless of the rate, the quality of the digital audio output was poor. Even though the board passed the CD's line input through to the speakers cleanly, both 22- and 44.1-kHz recordings were distorted and scratchy. We tried several board adjustments, only to find that some settings locked up our

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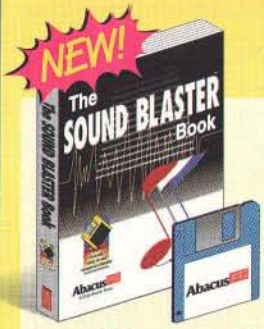

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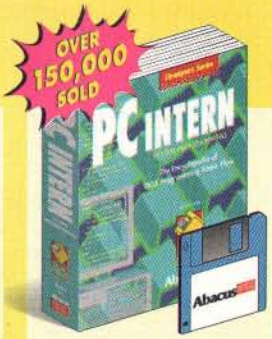

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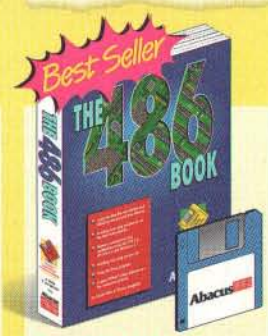

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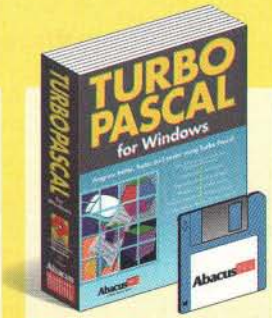

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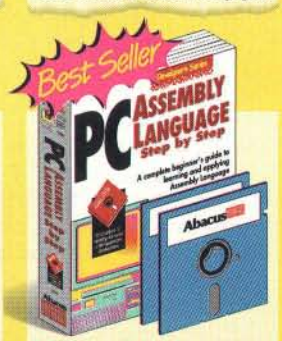

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system with parity errors and others seemed to run but produced no sound (and no error messages).

Audiomedia II

Digidesign's Audiomedia II ($1295) is a DSP-based audio digitizing and playback board for the Mac (see the Sound Designer II section for bundled software). The board can plug into any Mac II–series machine with a free NuBus slot (you'll need a NuBus adapter for a Mac IIsi).

The Audiomedia II is compatible with a number of digitizing and sequencer programs: Sound Designer II, Deck, Studio Vision, and Cubase, to name a few. (Sound Designer II is bundled with the Audiomedia II.)

The Audiomedia II uses a Motorola 56001 DSP (digital signal processor) running at 33 MHz, capable of inputting or outputting two 16-bit channels of 44.1- or 48-kHz audio. (The 48-kHz sample rate is used by most DAT [digital audiotape] recorders. We did all our testing at the CD speed of 44.1 kHz.) Along the board's back are six jacks: two RCA audio jacks, two stereo-input jacks, and two stereo-output jacks. The board also has connectors that let it talk directly (i.e., digitally) to DAT drives.

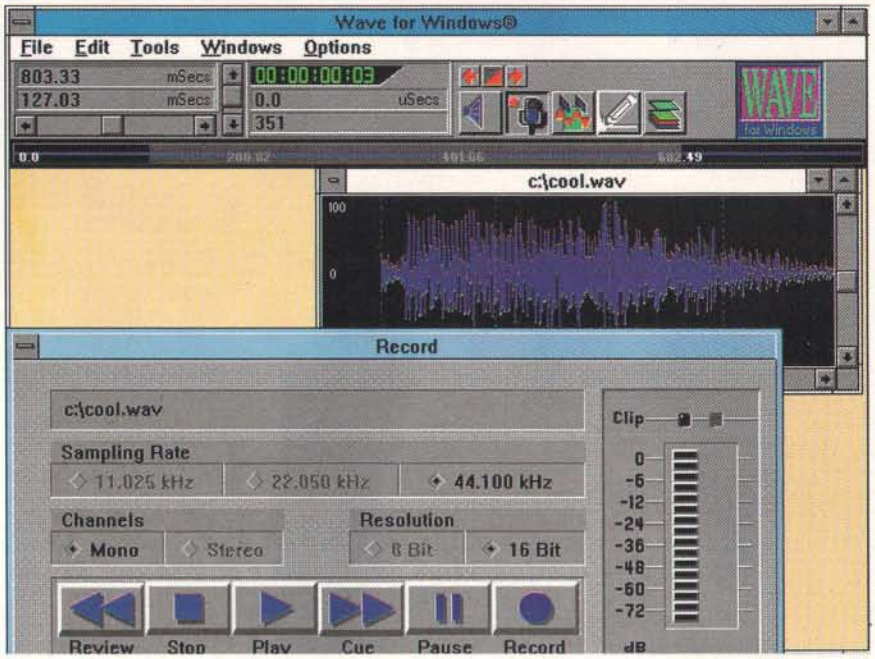
Installing the board is simple. There are no DIP switches, and the supplied installation floppy disk moves the drivers into their proper place in your system folder. For the most part, the board is self-configuring, and it delivers high-quality audio that sounds as if it came straight from a CD player.

Our Favorite Sound Boards

MultiSound is our clear choice among PC sound boards because of its combination of high-quality digital audio sound and the Proteus synthesizer chip. You can get pretty close to it, however, by pairing the Pro Audio Spectrum 16 and the Roland SCC-1. Wire these two boards together, and you'll have a sweet-sounding combination, giving you 95 percent of the MultiSound's digital audio quality with electronic music that's just about as good as it gets. In the bargain, you'll gain a CD-ROM controller (if you need it) and some helpful sound-shaping controls like equalization and stereo enhancement.

On the Mac, the Audiomedia II works with most sequencer packages and yields CD-quality recording and playback, as well as DAT-compatible outputs if you need digital all the way. It represents a solid addition to a Mac-based multimedia studio. For a look at the best sound board we've seen for the Amiga, see the text box "SunRize for the Amiga" on page 184.

DIGITAL AUDIO EDITORS



Wave for Windows

Turtle Beach Systems, maker of the MultiSound audio board, also created this worthwhile digital audio editor for Windows. For some applications, Wave ($149) is overkill. It offers so many ways to alter your data and such minute control that its overhead can make big jobs almost too tedious to bear. But much of that tedium isn't Wave's fault. The huge amounts of data it had to move around considerably slowed even the Uniq 486/50 with its cached EISA SCSI controller. So take what follows with this caveat: If you're dealing with more than a few seconds of data, the results we rave about take time to produce when you're working with 16-bit 44.1-kHz audio.

Wave uses the Windows Multimedia Extensions to acquire and play digital audio files, but everything else it does is pure Wave. Well-constructed dialog boxes guide you through operations such as the blending of multiple audio files into one and translating into different file formats and resolutions. Again, some of Wave's most advanced features can take several minutes per second of audio to enact. The wait, however, is worth it.

Wave has one feature—a time compress/expand filter—that seems made expressly for presenters. To reduce a sound clip's playing time, you drag a slider until either the percentage of playback speed or your desired target playing time appears. In one case, we took a 10-second clip of 22-kHz stereo audio and cut it to 65 percent of its original playing time. Wave churned for a couple of minutes, but when it was done, the time-compressed audio was indistinguishable from that which followed it—its pitch, dynamics, and all other attributes remained identical, but the file played in less time. It was so accurately converted that we could not identify the exact place where playing speed returned to normal.

Wave successfully wraps complex transforms (essential when you're building audio for presentations) in an interface that simplifies them. Those who take the time to learn to use its less apparent riches will find Wave to be one of the most worthwhile MPC-compatible tools yet offered.

Sound Designer II

Digidesign's Sound Designer II is a digital audio recording, editing, and playback package for the Mac. (The company bundles it with its Audiomedia II board.) Sound Designer II deals only in digital audio tracks. You will want a MIDI driver and interface, however, since Sound Designer II's output can be transferred to virtually all the popular samplers. You will want a MIDI connection for synchronization purposes: Sound Designer II understands MTC.

Under Sound Designer II's hood you'll find a 10-band graphics equalizer, a parametric equalizer, and other features that let you improve or alter sounds. A built-in mixer lets you mix up to four sound files (mono or stereo) into a single sound file. A

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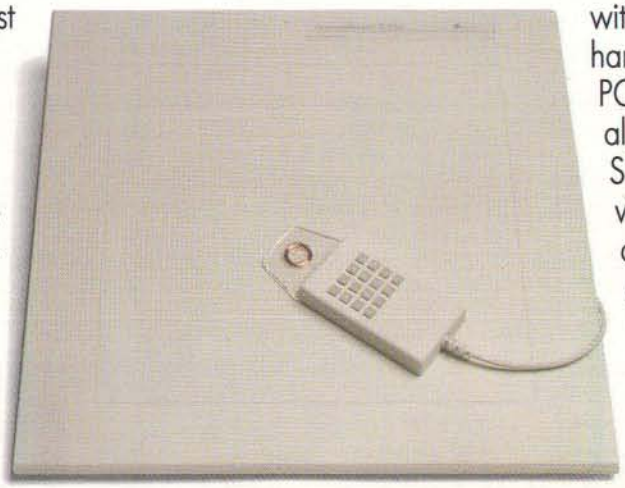

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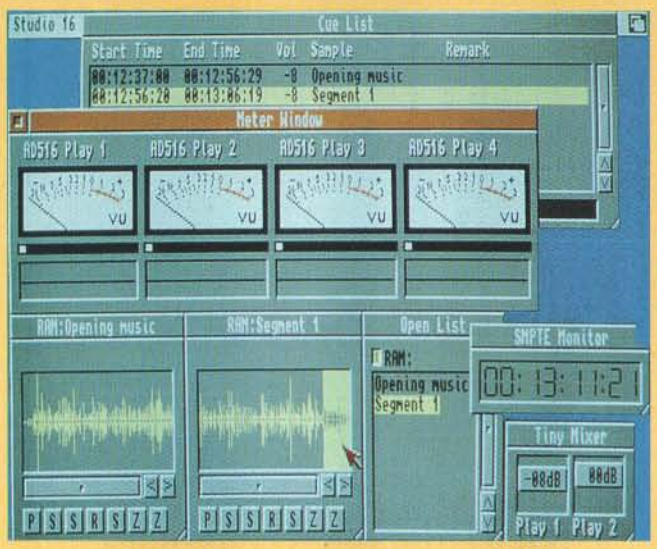
SunRize for the Amiga

TOM YAGER

The AD516 audio board from SunRize Industries is a great application of DSP (digital signal processor) technology. This board, which fits in an Amiga 2000 or 3000 series, delivers up to eight independent channels of 16-bit audio, with sampling rates of up to 48 kHz. (The Audiomedia II for the Mac, by contrast, has only two channels.) It understands SMPTE time codes, allowing for precise synchronizing of audio and video.



Taking Advantage

The $1495 combination of the AD516 and Studio 16 (the software that drives it) brings you very close to having an eight-track professional recording studio in your computer. Studio 16's interface takes marvelous advantage of the Amiga's multitasking capabilities by assigning the tasks of recording, editing, and playing digital audio to individual tools that can be launched and dismissed as you need them.

Using Studio 16 feels very much like working with a multitrack audio recorder. The difference is that you can record only two tracks simultaneously. That's not a hindrance for most kinds of presentation audio work, where you most commonly bring together elements that need not be precisely synchronized (e.g., music and narration). Studio 16's interface makes that kind of project a breeze, even allowing you to digitally mix-down multiple audio tracks into a more compact single file. Studio 16's editing capabilities are limited compared to some of the Mac and PC tools reviewed in this Solutions Focus, but the essentials—fade, resample, cut, and paste—are all available.

Hear the Effects

The AD516 board can capture fresh audio at any of 14 sample rates ranging from 5.5 to 48 kHz. The board's 22-kHz setting is astonishingly good. When you pop up the dialog box for choosing the sample rate, the AD516's audio input is processed by the DSP in real time, so you can immediately hear the effects of varying rates before you commit any disk space. The 44.1-kHz setting produced music indistinguishable from the CD that I was using as input.

The total cost of an AD516 board, an Amiga, and a large SCSI hard drive represents a fraction of the cost of analog systems that deliver comparable quality and capabilities. *No* analog system offers you the benefits of instant random access and digital processing.

unique twist on the concept of mixing is Sound Designer II's ability to merge two sounds. This is a kind of audio equivalent to video morphing, letting you transform one sound into another in a controlled way.

As you build up a collection of sounds, Sound Designer II lets you organize them into a *playlist*, a list of files containing your digital audio effects or snippets of music. So, for example, if you've made a single recording of a number of industrial sounds—drills whirring, hammers banging, and the like—you can seek through that track and mark the beginning and ending points of the individual tool sounds. You name these intervals of sound and use them to build your playlist, which lets you call up each element individually or in a predefined sequence. A playlist can handle most jobs that you might initially think would require cutting and pasting—and do the job faster, thanks to a smaller processor load.

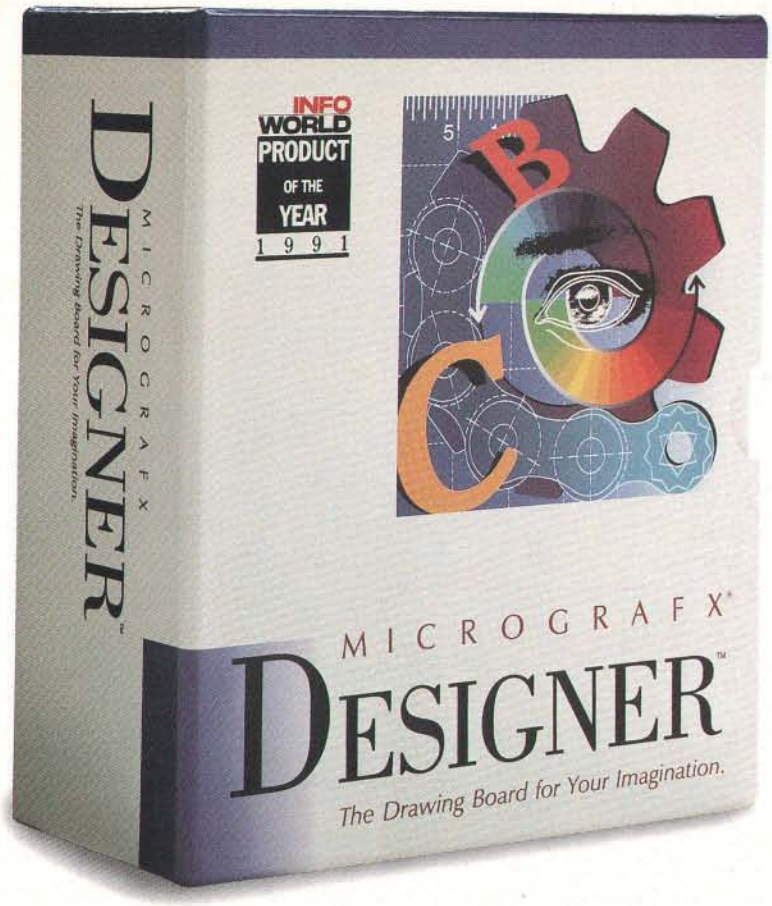
You can tweak Sound Designer II to optimize its performance on your hardware. For example, you can tell it to preallocate space for incoming digital audio; this option creates a large contiguous file *before* the system begins recording, thus eliminating the operating-system overhead that would take place as the file grows during the recording process.

As you might expect, Sound Designer II's record and playback window uses the tape-deck paradigm. It was so simple to operate that we made our first recordings without cracking the manual. That's how Sound Designer is: You need the manual only when you want to explore the package's more esoteric features.

Audioshop

Opcode Systems' Audioshop is a painless digital audio recording, editing, and playback system for the Mac. As the screen above shows, the interface looks like a CD player seen head on. Its output is through the Mac speaker, and it takes its input from whatever hardware is using your Mac's sound manager. (Newer Macs include a built-in microphone port; otherwise, you use a third-party device, such as Macromedia's MacRecorder, that plugs into one of the serial ports.)

continued



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Designer system requirements: 286 (386 recommended) IBM PC or compatible, or PS/2. 1 MB RAM (2 MB RAM recommended). 20 MB (or larger) hard disk. Windows 3.0. DOS 3.1 (or higher).
Mouse or digitizing pad. Windows-compatible monitor.

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COMPARISON OF SEQUENCERS

The major difference among these sequencers is whether they can handle digital audio files. (● = yes; ○ = no; N/A = not applicable.)

	Macintosh				Amiga
	Cubase Steinberg Jones	Deck Digidesign	Master Tracks Pro5 Passport Designs	Studio Vision Opcode Systems	Bars&Pipes Blue Ribbon SoundWorks
MIDI					
Maximum pulses per quarternote	384	384	240	480	192
Quantize/humanize	Q & H	None	Q & H	Q & H	Q & H
Graphical edit of continuous data	●	○	●	●	●
Digital Audio					
Maximum number of audio tracks	Unlimited [2]	4	N/A	Unlimited	N/A
Normalizing	●	●	N/A	●	N/A
Noise gating	●	●	N/A	●	N/A
Equalizing	○	●	N/A	○	N/A
General					
Import formats	SD2, STDM	AIFF, SD2, STDM	STDM	AIFF, SD2, STDM	STDM
Export formats	SD2, STDM	AIFF, SD2, STDM	STDM	SD2, STDM	STDM
Notation display	●	○	○	○	●
Multiple tempo settings	●	○	●	●	●
Mix-down automation	●	●	●	●	●
Synchronization	MC, MTC	MC, MTC	MC, MTC	MC, MTC	MC, MTC
Audio file compression	○	●	N/A	○ [2]	N/A
Most significant features	True real-time operation; nondestructive quantize	Track bouncing	Event-list editor; "fit-to-time" function; real-time editing	Real-time editing; color-coded instruments; audio-file consolidation	Graphical tempo map; supports SunRize boards
Price	$299	$349	$495	$995	$379

[1] Studio Vision uses sequences and tracks; 99 tracks per sequence.
[2] With Cubase Audio add-on.

AIFF = Audio Interchange File Format
MC = MIDI clocks
MTC = MIDI Time Code

SD2 = Sound Designer II
STDM = Standard MIDI (single or multitrack)

Like Sound Designer II, Audioshop builds playlists, assigning each element of a playlist a track number. You call up a particular track via the keypad on the Audioshop front panel. Pressing the playlist button reveals a scrollable window of playlist items. You simply double-click on an item name to open the waveform editing window. From here, you are able to perform all your cutting, pasting, and other digital audio magic, as well as manipulate special effects such as echo, reverb, and flanging.

When you are done editing, you can save tracks in a number of formats, including AIFF (Audio Interchange File Format—simply put, a format that specifies how to store digital audio), as a sound resource, or for use in programs such as Macromind Director.

Audioshop ($89.95) comes with two disks of sampled sounds. One is a collection of 25 sound effects—all quite good—and four or five musical passages—all mediocre.

SEQUENCERS

Studio Vision

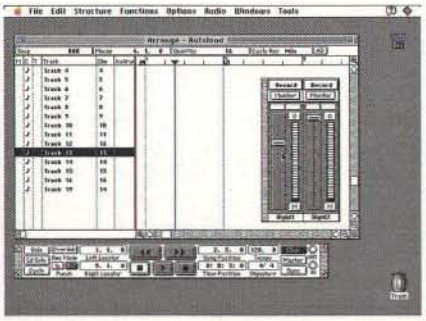
Opcode Systems' Studio Vision for the Mac ($995) is a digital audio and MIDI sequencer that runs atop OMS (Opcode MIDI System), an elaborate MIDI manager that can recognize various MIDI interfaces. Applications that are "OMS-aware" can request OMS to describe the current MIDI arrangement and thereby configure themselves.

Most sequencers store information on tracks, in keeping with the analogy to tracks on tape decks. Not so with Studio Vision. Instead, you build up a composition as a collection of sequences. The program allows up to 26 sequences, but within each sequence is a virtually unlimited number of subsequences. You determine your composition's overall form by telling Studio Vision the order in which to play the sequences. This naturally moves you in the direction of building phrases that you connect to form the complete piece.

Studio Vision's mix-down features allow up to 32 faders, each of which you can set to send to a MIDI controller (e.g., velocity) on a selected instrument. If you move a fader while you're recording, Studio Vision repeats that movement on playback. Also, if you want to control Studio Vision's faders during a live presentation, you can program them to be driven by an external MIDI device. You can also associate a Studio Vision command with an event sent from a MIDI device (e.g., the topmost F# on your keyboard can trigger Studio Vision to begin playing a sequence).

Studio Vision's combination of digital audio and MIDI data made it our Mac favorite. Other packages (see below) have similar capabilities, but Studio Vision made it easy to get as deep into both audio and MIDI data as we wanted. It's a marvelously complete package.

Windows		
Cadenza Big Noise Software	Cakewalk Professional Twelve Tone Systems	Master Tracks Pro 4 Passport Designs
480 Q & H ●	480 Q & H ●	240 Q & H ●
N/A N/A N/A N/A	N/A N/A N/A N/A	N/A N/A N/A N/A
STDM STDM ● ● ● MC, MTC N/A Notation printout; dedicated edit toolboxes	STDM STDM ● ● ● MC, MTC N/A Graphical editing; supports MCI; plays back .WAV files	STDM STDM ○ ● ● MC, MTC N/A Supports MCI; event-list editor; "fit-to-time" function
$299.95	$349	$395



Cubase

Cubase from Steinberg Jones is a $299 Mac sequencer that distinguishes among various "track" types: MIDI tracks, drum tracks, group tracks, mix tracks, and tape tracks. If you add Cubase Audio—a module that you "plug into" the basic Cubase—the system can handle audio tracks. Although drum tracks internally carry the same kind of data as MIDI tracks, drum tracks are treated differently because MIDI systems can assign different drum sounds to different notes; it would get confusing if you had to remember which key was your cymbal and which key was your snare drum. Group tracks let you collect tracks together that represent, for example, your string section, and operate on the group as a unit.

Cubase lets you examine your music in standard music notation form through the Score Edit window. There are options for fine-tuning what you see in the notation window. For example, you have to tell it what key the music is in. The results are often bizarre, but remember, the poor thing is trying to ascertain the nuances expressed in music notation from raw MIDI data.

One of the package's more interesting editing capabilities lets you perform logical operations on tracks of MIDI data. You tell it something like "for all notes below middle C, add +1 to their velocity"; it's not unlike group operations you might perform on a database. This makes what would otherwise be difficult editing easy, as well as allowing for the creation

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of musical effects that would be tedious to duplicate.

Cubase supports most audio-editing capabilities, such as cutting and pasting and modulating tempo and volume. The audio editor window's magnification controls are blessedly easy to operate.

Cubase is a good choice for synchronizing audio and video because the program can output MTC, MIDI clocks, and pure SMPTE time code. Steinberg Jones also offers a Windows version.

Deck

Developed by OSC Products and sold by Digidesign (maker of the Audiomedia II board), Deck for the Mac ($349) takes the model of the simulated tape deck to an extreme. When you launch Deck, you are presented with a screen-size image of a four-track tape deck complete with faders, push buttons, bar-graph meters, and transport buttons. Actually, Deck is more than just a four-track system; there are four audio tracks, but the program can handle up to 32 MIDI tracks as well.

Although Deck doesn't let you dig into the actual data on a track (there are no waveform displays, piano rolls, or MIDI data list displays), you can perform filtering, effects, and editing operations on both MIDI and audio data. If your audio data has become noisy or has incurred a 60-Hz hum, you can unleash Deck's noise gate or hum-removal signal processing on the data. Many of the audio effects are available to Deck only if you are running it with the Audiomedia II.

Deck's MIDI-editing window lets you merge tracks (the MIDI equivalent of mixing two audio tracks together). You can also filter specified MIDI events or delete all MIDI events associated with a specified channel within a track.

Deck's automated mix-down capabilities are especially well done. Essentially, you build a collection of up to eight mixer *states*; a state is a particular arrangement of all the controls on the display. You can call up a state by pressing one of the state buttons at the bottom of the display. You then play your session, pressing state buttons as you listen to the playback. The next time you play back your session, Deck recalls the states for you at precisely the times you selected them.

Master Tracks Pro 5

MTP5 is Passport Designs' no-nonsense MIDI sequencer for the Mac. (The PC version is discussed below.) MTP5 ($495) is strictly MIDI, and although it has no digital audio component, it's no product to look down your nose at.

MTP5 handles MIDI data display and editing via a modified piano-roll display, but that's not your only way to modify data. The program has an impressive set of filters that let you target specific kinds of MIDI events for editing. For example, one change filter lets you raise the velocity of every third beat in a four-beat measure.

You can edit continuous data by simply drawing and erasing waveforms in one of the controller windows. If your continuous data becomes too dense (e.g., your composition is sending so many pitch-bending commands that it's overwhelming the MIDI port), MTP5 lets you "thin" the controller commands. This has the effect of sending fewer control-change commands. Of course, this also produces a coarser resolution (in our pitch-bending example, the pitch would change in possibly audible jumps), but MTP5 lets you tweak the thinning to strike a balance between MIDI traffic and sound quality.

All in all, this is a fine product. Its designers have had time enough to work out the kinks and perfect its user interface.

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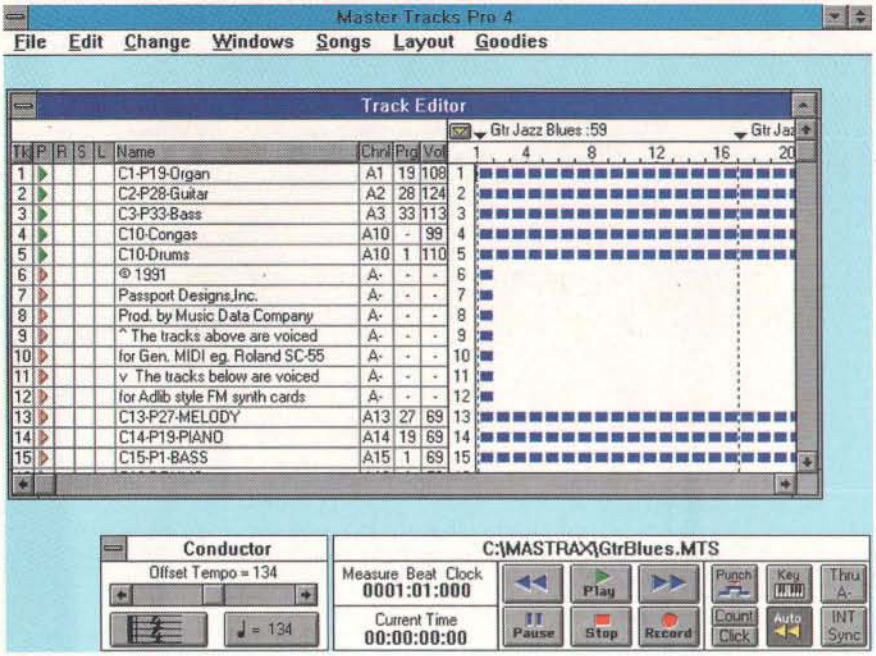


Master Tracks Pro 4 for Windows

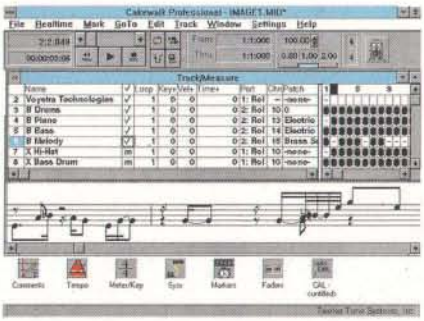
MTP4's standard screen—a track-editor window split between a graphical score and a track-parameter area—puts more useful information in your face than any other sequencer we have seen. Volume, MIDI channel, instrument (program) number, track play/record status, and measure-by-measure activity indicators all appear in one window. This effective use of limited screen space is one thing that sets Passport Designs' MTP4 apart. Its long, impressive list of capabilities distinguishes it as well.

MTP4's multitrack mode will record multiple MIDI channels simultaneously. This is useful for transferring data from an external sequencer. MTP4 lets you very easily move the data around, copying, cutting, pasting, or inserting as little as a beat's worth of music to any track.

If you want more detail, pop up the step editor, which shows either note data alone or all MIDI data as bars whose length and position reflect the pitch and duration of every note in your score. If you want still more detail, you can pop up a MIDI event editor. This shows every aspect of every MIDI event, including the key-down, key-up, and aftertouch velocities. You can edit any piece of data in the event editor.

A special record mode lets you alter a track's volume while it plays, interleaving those volume changes with the track data. MTP4 remembers where and when you moved them, creating a fully automated mix. Another notable feature is "humanization," which randomizes a note's starting time, duration, and velocity to give computer-generated music a less mechanical feel.

MTP4 ($395) is the best Windows sequencer for making changes to canned MIDI music and for packaging original MIDI sequences into well-orchestrated sound tracks. You needn't be a musician or a producer to run it, but the closer you are to one of these, the more you'll get out of MTP4.

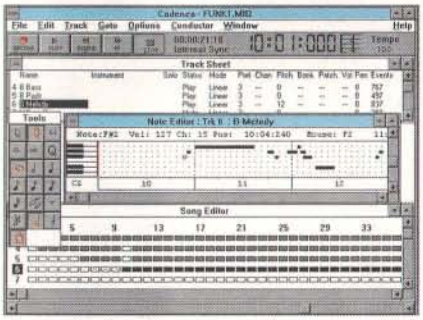


Cakewalk Professional for Windows

If you run Twelve Tone Systems' Cakewalk ($349) and Passport Designs' MTP4 side by side, the similarity is striking. But while the interfaces resemble each other, Cakewalk's handling of similar procedures pales against its competitor's. The transport interface, for one, lacks both the completeness and simplicity of MTP4's. Cakewalk's track window is split just the same as MTP4's but is missing the common-sense shortcuts Passport built into its interface. Many operations feel awkward by comparison.

Cakewalk has a nicely done staff sheet, showing a notated version of one or more tracks. During playback, a cursor ticks off each beat, and the program manages to keep the score view updated very well. But the score window sometimes appears without a vertical scroll bar, forcing you to grow the window to see even one staff. Similarly, when the MIDI event editor first appears, it comes up in a window without a title bar; there is no system-menu icon and no cancel button, and hence no obvious way to dismiss it. As it turns out, the title bar and system menu appear when you resize the window. These are only two examples of how Cakewalk's interface gets in the way of even simple tasks.

To its credit, Cakewalk's score view is notable. Its functionality is limited, but you can edit notes. For those who can sight-read, the score view is extremely valuable. You would not use it to build a song from scratch, but as a proofreading and simple editing tool, the score view adds considerably to the value of Cakewalk. Despite its sometimes awkward interface, Cakewalk proved reliable and capable enough.



Cadenza for Windows

Big Noise Software's Cadenza ($299.95) is a bit less capable than MTP4, but it's distinguished in its own right for being capable and compact. The interface is manageable and unpretentious, and it places in your hands most of the tools you need to mold a MIDI song to your liking.

The track view lacks program names and presents its data in raw and somewhat hard-to-read columns of unadorned text. But the values *are* editable, each responding to a double-click of the mouse with a dialog box that presents the valid options for change. You can drag down a column of entries and change them all at once—a real time-saver for the wholesale changes involved in a reorchestration session.

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The Advantages of Sequencers

The first computer-based sequencers were MIDI-only. Now, thanks to large, fast hard drives coupled with large memory capacities and powerful CPUs, a new generation of sequencers can handle MIDI *and* audio tracks. Here are a few of the many benefits sequencers give to people developing presentations:

• A sequencer package's simulated tape deck suffers from none of the disadvantages of a real tape deck. There is no tape hiss; you can rewind instantaneously; you can replay, erase, and rerecord indefinitely with no degradation to the medium; and you can position the tape precisely where you want it and overdub with microscopic accuracy. In short, all the problems associated with moving parts, friction, and analog electronics are pretty much gone.

• With sequencers that can handle digital audio as well as MIDI tracks, you can now record voice along with your musical production, and the voice will be in synchronization with the MIDI data. There's no need for an external tape deck. If you're carrying hardware to a presentation, that's one less box you have to worry about.

• You can build up a library of sound effects. Suppose you're doing a presentation and want the sound of an explosion to usher in a critical frame in your visual sequence. You can just pull the sound from the proper subdirectory and punch it into an audio track right where you need it.

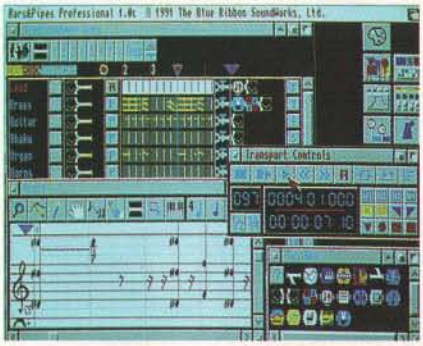
• Most sequencers provide graphical editing of the audio data, so they're relatively easy to use. Tape splicing becomes a cut-and-paste operation. And you can undo many editing mistakes as if you were working in a word processor—operations that a real tape deck simply can't handle.

• Many sequencers provide automated mix-down. In its simplest form, this means that you can program faders (volume controls) for each track so that, at playback time, the faders move according to your preprogrammed sequence. For a 32-track system, it's like having 32 robot hands on each of the volume knobs, making one instrument louder in the beginning, another one softer to the end, and so on. This puts recording-studio sophistication into the reach of small TV and radio stations, company PR departments, and others.

Many elements in Cadenza bear similarities to elements in MTP4, from the "one block per beat" song editor to the bar-oriented note editor (see the screen). The resolution of the note editor proved insufficient at times, with very brief notes refusing to respond to any mouse action but a lengthening of their duration. Notes in the note editor play when you move them but not when you click on them.

Control changes can be made not only in the event editor, but also in editors in which you draw curves to represent the control's setting over time. Volume, velocity, aftertouch—any MIDI controller can be set in this way. We found the mechanism flawed, however. When we used the control editor to fade a drum track in through increasing velocities, it imposed velocity changes on portions of the track that should have remained unaffected. Cadenza will undo your most recent change on request, and that returned the music score to its original state, but we were not able to make the desired change.

In another test, we tried applying the humanizing filter to a selected block of MIDI data. Although we used very modest randomizing values, several notes simply vanished from the score. We liked Cadenza—it's a good, basic MIDI sequencer—but the problems we encountered forced us to give it lower marks than other contenders.



Bars&Pipes Professional

Blue Ribbon SoundWorks' sequencer for the Commodore Amiga, Bars&Pipes Professional ($379), is among the best available. The program's interface relies on the elements that make up its name. The bars represent musical notes and their durations; the pipes are the virtual conduits through which MIDI track data flows. The theory and Bars&Pipes' implementation of it add up to a compelling program.

Called tools, Bars&Pipes' filters are represented by icons you drag into position in either the inflow or outflow pipes. They lock into position and modify the MIDI data flowing through them. One tool transposes MIDI notes, and another creates complex counterpoint melodies. One of the remarkable aspects of Bars&Pipes' tools is that they all work in real time.

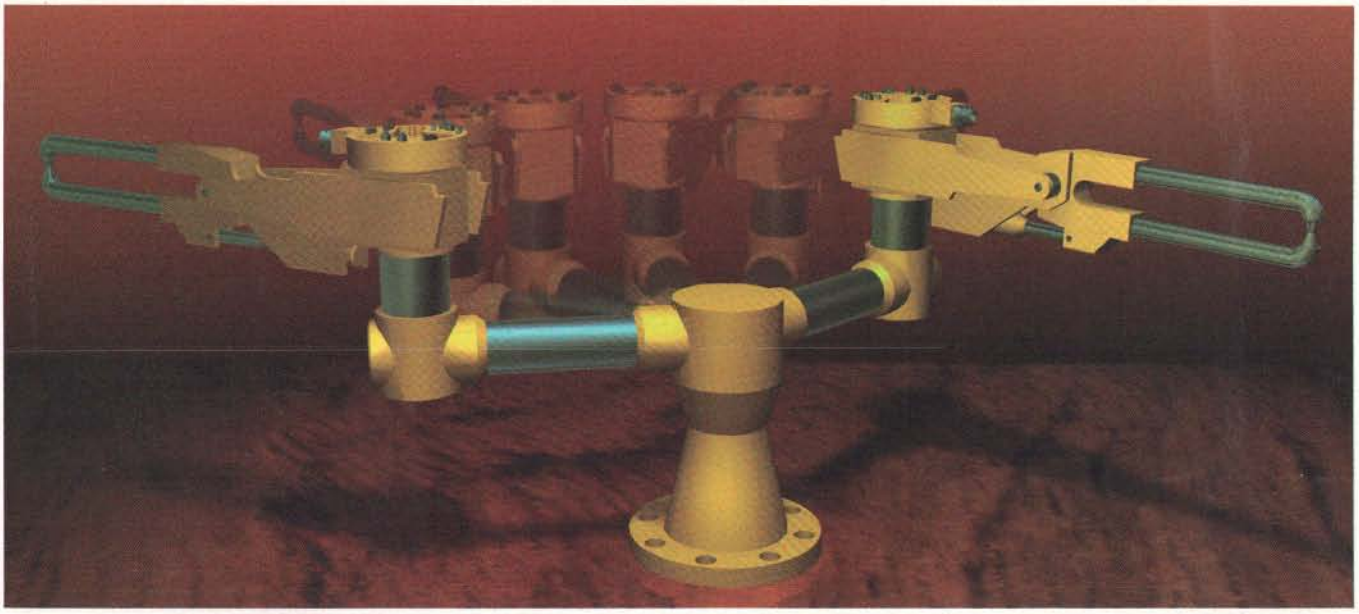
Bars&Pipes places an incredible number of resources in the hands of those creating production music. Reorchestration by changing instrument assignments is easy, but Bars&Pipes also lets you create counterpoint and harmony, arpeggiate chords, and filter out notes that fall outside a specified key. Normally, the tools don't affect the score; they operate on MIDI data after it comes in from an external source, before it flows out through the Amiga's serial port, or both. You can, however, apply any tool to a track or part of a track to permanently alter the track's data. You can save the altered result as an ordinary MIDI file.

Bars&Pipes' mostly graphical approach to sequencing makes this program perfect for those unfamiliar with MIDI. If you have no preconceived notions of how sequencers should behave, learning will go smoothly. But the graphical approach also makes editing individual MIDI events harder than necessary by making it an exclusively point-and-click affair. If you plan to work with presentation music, even a low-end Amiga paired with this program gives you all the power you need.

Our Favorite Sequencers

On the PC running Windows, Master Tracks Pro 4 is the best sequencer for

These are typical AutoCAD drawings.



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AUTODESK

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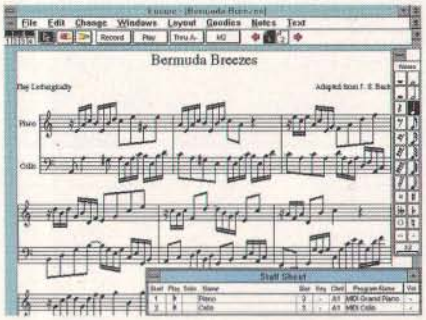
making changes to canned MIDI music and for assembling original MIDI sequences into a presentation soundtrack.

If you're a Mac user working only with MIDI files, Master Tracks Pro 5 is as solid as a rock. If all you're after is capturing digital sound effects for playback during an application program on your Mac, Audioshop is easy to handle and provides plenty of special effects. Music professionals who need digital audio plus MIDI, but who aren't enthralled with personal computers, will likely feel most comfortable with Deck. However, for a package that lets you get down into the data—MIDI and digital audio—Studio Vision is our favorite.

On the Amiga, Bars&Pipes Professional gets our vote as the top sequencer.

Encore

At the heart of Passport Designs' notation editor is a desktop publishing system for music. If printed sheet music is your objective, Encore ($595) is a fine way to get it. The software can convert MIDI data to notation and notation to MIDI data. One of the slickest uses for a program like this is to transcribe orchestral scores and turn them into lush, multitrack MIDI sequences. Encore lets you do that, but it's not as good



at it as we had hoped it would be.

Encore uses Adobe Type Manager and Adobe's Sonata music font to display and print beautifully drawn notes and symbols. That's where Encore excels: It produces gorgeous sheet music from original compositions, copied scores, and MIDI files. Where it falls short is in its ability to translate what appears on the page to MIDI data.

Getting notes onto Encore's electronic staff is easy. You can either drag them from a note palette (shown in the screen above) or use the keyboard to select note durations. As you place a note, it plays through whatever MIDI device you've configured under Windows. Encore automatically beams notes together according to beat, and it lets you create as many staves as you like in as many different configurations as you like.

Once you get the notes down, Encore lets you add lyrics and graphical elements like dynamics, crescendos, slurs, and pedal marks. Unfortunately, Encore ignores these elements when it plays your MIDI score. You do have control over most of those things, either by setting playback attributes in Encore or (more easily) changing them in another sequencer. The problem, however, is that you have to do everything but the notes twice: once to get the score right on the screen, and again to make the MIDI playback match the display's representation.

That makes Encore a poor choice for turning printed scores into presentation music. It is skilled at turning MIDI data into great-looking notation, and it gives you a fine set of publishing tools. ■

Tom Yager is director of the BYTE Multimedia Lab and author of the Multimedia Producer's Handbook *(Academic Press, forthcoming). You can contact him on BIX as "tyager" or on the Internet at tyager@bytepb.byte.com. Rick Grehan is technical director of the BYTE Lab. You can reach him on BIX as "rick_g."*

COMPANY INFORMATION

Big Noise Software
(Cadenza for Windows)
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Blue Ribbon SoundWorks
(Bars&Pipes Professional)
P.O. Box 8689
North Highland Station
Atlanta, GA 30306
(404) 377-1514
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Cardinal Technologies, Inc.
(SoundStudio)
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Lancaster, PA 17601
(717) 293-3000
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Digidesign, Inc.
(Audiomedia II, Deck, Sound Designer II)
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(Audioshop, Studio Vision)
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(415) 856-3332
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Passport Designs
(Encore, Master Tracks Pro)
100 Stone Pine Rd.
Half Moon Bay, CA 94019
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Roland Corp.
(SCC-1 GS, Sound Canvas)
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(Cubase)
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SunRize Industries
(AD516, Studio 16)
2959 South Winchester Blvd.,
Suite 204
Campbell, CA 95008
(408) 374-4962
Circle 1327 on Inquiry Card.

Turtle Beach Systems
(MultiSound, Wave for Windows)
1600 Pennsylvania Ave.,
Unit 33
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fax: (717) 854-8319
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Twelve Tone Systems, Inc.
(Cakewalk Professional for Windows)
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Watertown, MA 02272
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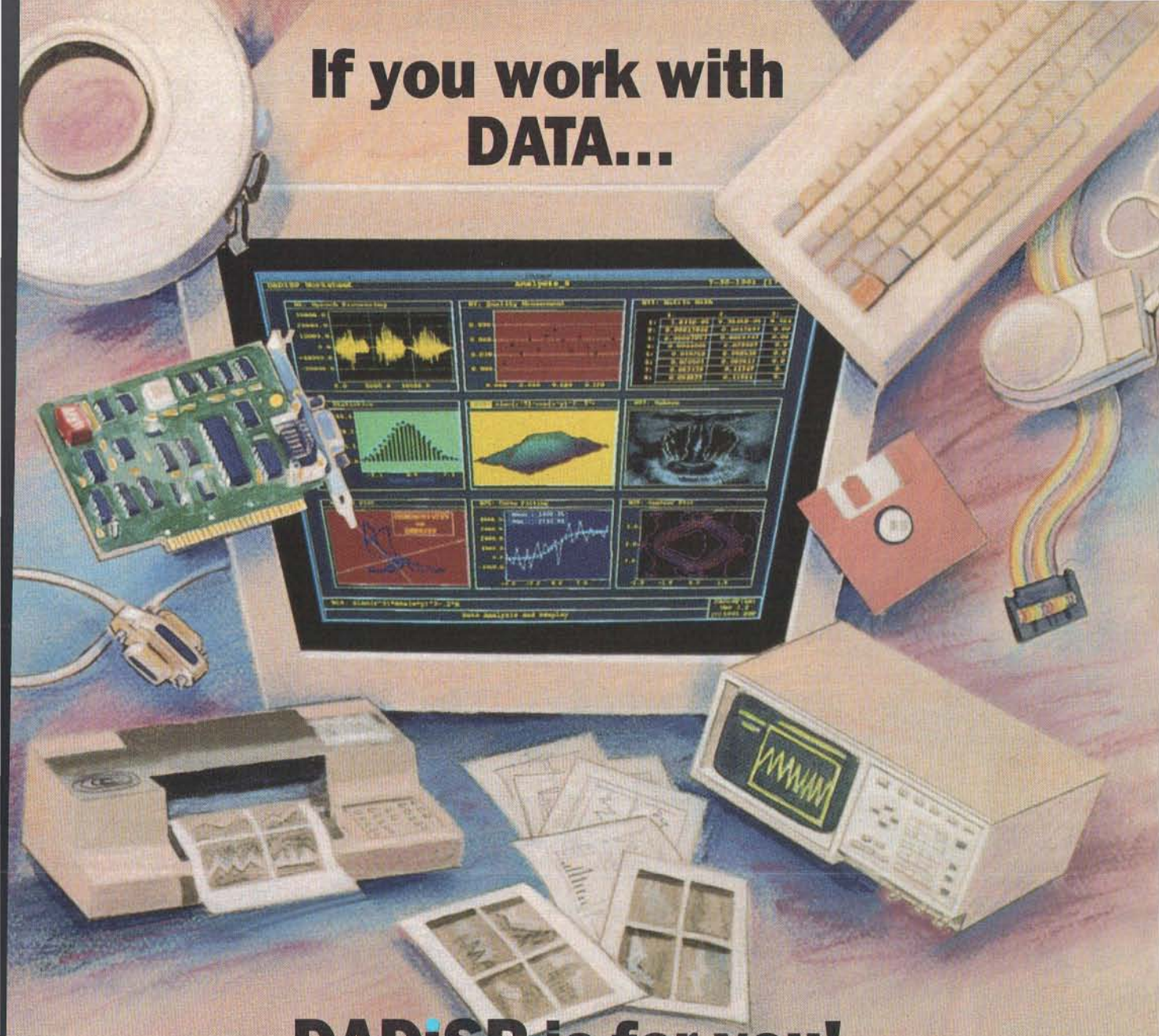

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SOFTWARE

Windows BASICs

MIKE WIGGINS

Since Windows first came out, nonprofessional programmers have been screaming themselves hoarse for an easier way to access the power of the environment. While the resource editors available for C have come a long way, the C environment still leaves people a bit dry.

Windows BASICs make it easier for people to program Windows. Specifically, they allow any programmer with reasonable experience to create a user interface without having to know the API calls. The ability to create a full-blown Windows application without the tedious programming is quite appealing.

Who can use Windows BASICs? Anybody who wants to create a program in Windows and doesn't have the time to learn C and Microsoft's SDK (Software Development Kit). Getting your first program up and running may take hours instead of weeks and months. If you need to develop any type of DLL, you can't use a Windows BASIC program for that yet; none of these packages provides that level of complexity.

The latest Windows BASIC packages blend a rich programming environment with an intimate control over the Windows API (see the features table). CA-Realizer 1.0 ($395) offers a run-time compiler and Programmable Application Tools while shielding you from the naked Windows API calls.

GFA-BASIC 4.10 for Windows ($295) offers over 800 BASIC and Windows commands, direct calls to the API without the need for a DLL, and full 32-bit support for 386/486 processors. GFA Software Technologies also sells a $99 "QB" version of the package designed to take QuickBasic programs and convert them for use in Windows with minimal change.

Finally, Microsoft's Visual Basic 1.0 with Professional Toolkit offers the development environment, a run-time compiler, and a rich set of extensions with the Professional Toolkit. Visual Basic lists at $199 or, bundled with the Professional Toolkit, at $499. Microsoft is readying a significant upgrade of the product (see the text box "Coming Soon: Visual Basic 2.0" on page 200).

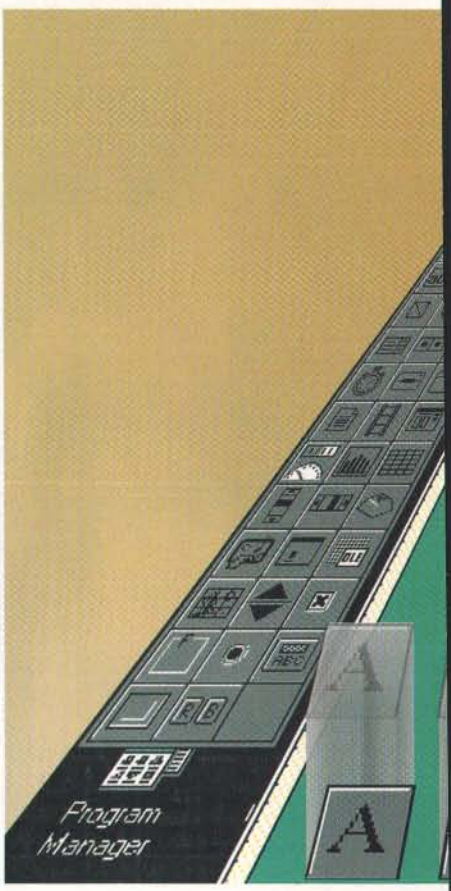
Each package lets you write Windows code without knowing C or the SDK. CA-Realizer and Visual Basic provide alternative SDK functions; GFA-BASIC offers direct access to the full complement of API calls.

The Language of Windows

Programming in C is the conventional way of programming Windows. For most folks, this is not an easy task, because you have to learn the ins and outs of Windows as well as C's delicate syntax. Conquering both at the same time is like trying to take a drink from a fire hose; you'll get some of it, but a lot will get by you.

Another way to program Windows is to use a visual programming language. These are generally believed to be easy to use, but they lack the full power of a programming language. Windows BASICs are somewhere in between the visual languages and C. They give you the ability to access Windows without having to deal with all the endless details of pointers and the details of the API calls.

The heart of a Windows BASIC program is the *form*. The form contains the primary user-interface elements: control buttons, data-entry fields, and cubbyholes to tuck executable code into. In essence, a form is a Windows window, but an enriched one with your program's control structure built into it. In the old days, it was necessary to write pages of code to create interfaces; now there are handy resource editors to reduce that task to dragging buttons and checkboxes from a toolbox. When you combine the graphical design tools, straightforward BASIC syntax, and integrated Windows API calls, you get a Windows BASIC.



If you're not a programmer, the only thing these packages allow you to do is create a pretty screen. At that point, you'll have to find a friendly programmer to help you fill in the underlying structure.

Take a Message

To test these packages, I designed a simple application that duplicates the common "While You Were Out" message pad. It contains areas for whom the message was to and from, the date and time of the message, the phone number, a series of action checkboxes, and a short narrative message. A control panel next to the pad controls the application. The controls let you create a new message, save changes, and browse through the message database. The entire front end of the application uses Windows API calls through the environment's libraries and/or API access, and the back end uses the standard BASIC file I/O to manage a straightforward fixed-length record structure.

The first step in writing the application is designing the form. That's the resource editor's job, and each of the packages takes a slightly different approach to the problem. The resource editor is your primary interface to the package, so it had better

IMAGE: DIANA BEALE / IMAGESET DESIGN, INC. © 1992

BYTE ACTION SUMMARY

- **WHAT WINDOWS BASICS ARE**
  Running under Windows, these programs deliver a rich BASIC programming environment and intimate control over the Windows API.
- **LIKES**
  Visual tools make it easier for casual programmers to create applications. You can write Windows code without extensive knowledge of C or the Windows SDK.
- **DISLIKES**
  If you need to develop any type of DLL, you can't use a Windows BASIC program for that yet; none of these packages provides that level of complexity.
- **RECOMMENDATIONS**
  Visual Basic's design tools were superior to the others and felt the most like other Windows applications.

be a good one.

Each control then gets a connecting link to the underlying BASIC code. The general procedure is to select the button or checkbox and assign it a piece of code to execute. To build the database records, you extract the entered data from the form. The data elements have to be combined into a record and stored into a random-access BASIC file.

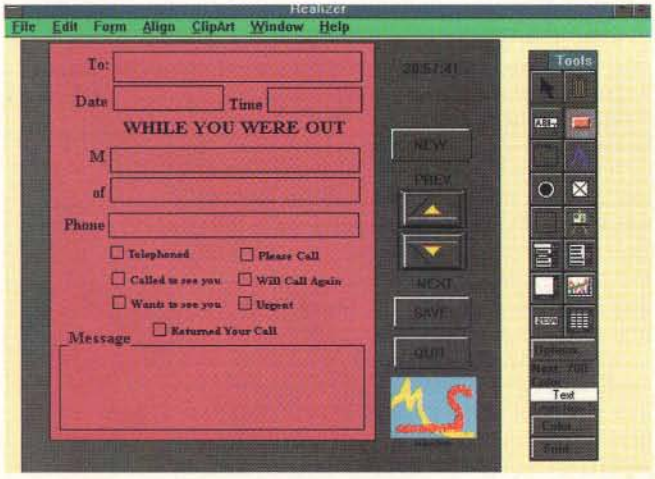
After you complete the form, the Action Item function in the Edit menu lets you write a chunk of BASIC code and attach it to that control. For example, in my sample application, when you press the Next button, its handler increments a record counter and reads the next message from the database. When you save the file, Realizer merges your neatly encapsulated routines into the main program.

CA-Realizer is an interpretive environment that lets you run your code right from the editor. Your program will probably work the first time (mine *always* do), but if not, Realizer's debugger lets you step through the program. The program editor is a standard Windows-style editor with multiple edit windows, cut-and-paste operations, and all the menu options where you expect them to be.

Realizer's Programmable Application Tools are roughly analogous to Visual

CA-Realizer 1.0

CA-Realizer lets you create a Windows application without extensive knowledge of the Windows SDK. You create the Windows front end with FormDev, a resource editor provided with Realizer that uses a convenient WYSIWYG drawing package to design the program's form. In Realizer, each form is a separate window. FormDev's toolbox contains the usual assortment of Windows drawing tools; you select objects with the arrow selection tool, place buttons with a tool shaped like a button, and create editing fields with the text tool (see screen 1). During the editing and design process, each element gets assigned a unique item number.



Screen 1: *CA-Realizer's resource editor uses a convenient WYSIWYG drawing package to design the program's form. At your disposal are the usual assortment of Windows drawing tools.*

FEATURES OF WINDOWS BASICS

All three packages blend a rich BASIC programming environment with an intimate control over the Windows API. (● = yes; ○ = no.)

	CA-Realizer	GFA-BASIC	Visual Basic
Price	$395	$295	$199; $499 with Toolkit
Windows API calls	With DLL	●	With DLL
Graphics support for BMP/PCX	●	●	●
Custom controls	●	○	●
Maximum array size	64 KB	20 MB	64 KB; 63 MB with DLL
DLL	●	●	●
DDE	●	●	●
MDI (Multiple Document Interface)	●	●	●
On-line tutorial	●	○[1]	●
Form-design tools	●	●	●
Multiple parent windows	○	●	●
Run-time executable [2]	●	●	●

[1] Tutorial is manual-based with sample code.
[2] All require a system DLL.

Basic's Professional Toolkit. The tools appear in the FormDev toolbox and include number functions such as charts, spreadsheets, boards, logs, active bit maps, and animation libraries. Realizer lets you expand your application through the use of DLLs and share information with other Windows applications though DDE.

Delivering the Goods

When you finish your application, you'll want to get it into your users' hands. Realizer's Project Builder is a simple way to create a Windows executable file, complete with its own icon and Realizer runtime library. The Project Builder scans the file and compiles a list of resources required to build the program. The end result is an installation disk complete and ready for royalty-free distribution.

I had CA-Realizer installed and my program running in a matter of hours. The documentation was easy to follow. The sample programs and on-line help system came in handy more than once.

A few things about the product annoyed me. Realizer fills the screen with a default window, and your application appears as a smaller child window. I would have liked to have my application fill the parent window. I worked around the problem by replacing the parent window's menu and pretending that the window came from my application. On FormDev, I'd like to see better control of the toolbox set, a global grid system so you can align items, and a grouping function that lets you move multiple items as a group.

I recommend Realizer to anyone with minimal programming experience and little or no prior knowledge of Windows API calls. CA-Realizer gives you plenty of examples, including the source for both FormDev and the tutorial. Of the three packages reviewed here, it has the highest level of abstraction to protect you from those tedious API calls. However, if you *need* to get to the API, you can—through the use of DLLs.

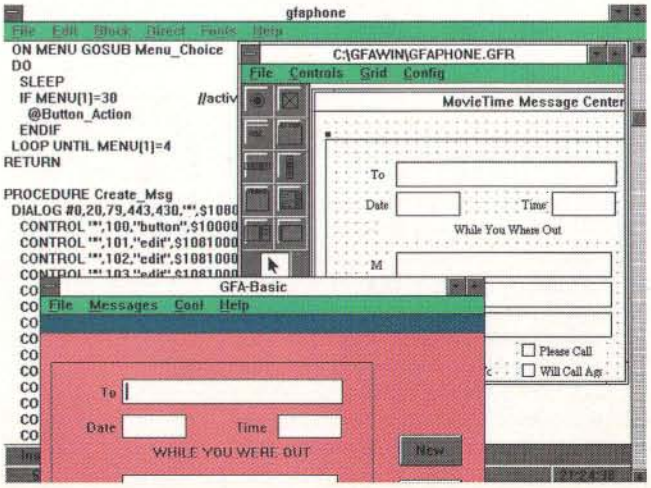
GFA-BASIC 4.10

A vast collection of BASIC commands and direct Windows API calls makes GFA-BASIC very powerful—perhaps the most powerful of the three products in this review. When you install the package, you select from a number of optimized interpreters and run-time DLLs for the various Intel processors, from the 286 to the 486 with full 32-bit support. GFA Software Technologies offers two flavors of its package: an MS-DOS version and a Windows version. Code written for one environment will run on the other if you simply recompile the program.

Your link to the package is the GFA-BASIC editor, which gives you a complete environment with a debugger and the RCS (Resource Construction Set)—similar to CA-Realizer's FormDev. Programmers familiar with WordStar editing commands can use those same commands in the GFA editor. For others, there's a Windows-style cut-and-paste interface. Unfortunately, the Windows editing controls are nonstandard and take a bit of getting used to.

You use the RCS to create dialog boxes. For the test application, I ended up creating a message-form dialog box and then calling it from the parent window (see screen 2). Another approach would have been to create the message form as part of the parent window and then use `CreateWindow` calls to define the form in the code without the benefit of a resource editor. That's harder from a programmer's point of view, but it lets you take better advantage of GFA's extensive Windows support.

GFA-BASIC has two primary advantages over its competition. First, the 800 functions, give or take a few, include math, communications, graphics, matrix, and dBase functions, all from the standard package. But it doesn't stop there. GFA also gives you full Windows API support without the need to call a DLL. Support for MDI (Multiple Document Interface),



Screen 2: *You can create dialog boxes from GFA-BASIC's RCS. For the test application, I created a message-form dialog box and then called it from the parent window.*

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The Major BBS Development Team with about 5% of the code they wrote and tested, line by line. From left to right: Bert Love, Edward Bush, Richard Skurnick, Tim Stryker, Bob Stein, Brian Stephens, Sheri Robert, Les Bird, Chris Robert, Scott Brinker, Chris Kotacka

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Coming Soon: Visual Basic 2.0

TOM R. HALFHILL

Visual Basic 2.0, announced in early November, promises to be a significant revision that adds more of everything: controls, properties, keywords, events, debugging tools, programming aids, and—perhaps most important—performance. What follows is a look at some of the significant new additions, based on preliminary documentation, a beta version of the software, and Microsoft sources.

VB 2.0 will be available in both a Standard Edition and a Professional Edition. The Professional Edition replaces the Professional Toolkit 1.0 and the Control Development Kit, and several features from Toolkit 1.0 have been added to the new Standard Edition. Among these are the OLE client control and the grid control, a spreadsheet object that has been improved over the version in Toolkit 1.0.

The toolbox in both editions has two new controls. The graphical control lets you create shapes, lines, and labels like earlier controls, but it uses fewer Windows resources so you can build bigger applications. The other new control is the image box. Like a picture box, it can display BMP and ICO graphics files, but unlike a picture box, it can resize the images as well. Also, graphics can be displayed in 256 instead of 16 colors.

All control properties in VB 2.0 are now displayed in a movable, scrolling window instead of a static list box. Global and type definitions, formerly allowed only in the GLOBAL.BAS file, can now be included in any code module (but not form modules). If you begin your declarations section with the new Option Explicit statement, VB 2.0 requires all variables to be declared before use. Although this feature imposes somewhat more structure on the programmer, it makes the source code easier to understand and maintain, especially in projects involving workgroups.

Several improvements make it possible to write larger applications. VB 2.0 allows four times as many procedures per application, twice as many variables per module, twice as many global variables, twice as many controls per form, unlimited string space (up to the limit of available memory), and arrays that break the 64-KB memory barrier (but only in Windows enhanced mode). You can put more than 255 controls on a form by grouping the controls in arrays, and you can also include arrays in user-defined variable types.

All indications suggest that Visual Basic 2.0 will be a significant upgrade and a release worth watching closely.

Tom R. Halfhill is BYTE's senior news editor in San Francisco. You can contact him on BIX as "thalfhill."

DDE, and DLLs rounds out this package nicely.

Building an Application

I used the RCS to create the message pad as a dialog box. The RCS offers a click-and-drag WYSIWYG interface. Oddly, font control wasn't one of the toolbox features. You can set a global font characteristic for the entire dialog box, but you can't set font styles for individual control elements. The "Please Call" area of the form should have used a smaller font for the checkboxes. In this case, picking one style for the whole dialog box caused the elements to be truncated on-screen.

After completing the form in the RCS, you save the form and send the code to the text editor. Once in the editor, you can view and change the CONTROL statements that make up the dialog box.

A conventional Windows program is based on a simple event-handling loop with separate handlers for each process. GFA-BASIC achieves its event-driven control with a different mechanism. The bulk of a GFA-BASIC program is a procedural program, written to look much like conventional BASIC. ON statements, such as ON MENU, provide each event with an interrupt handler, similar to the ON KEY and ON COM interrupts in conventional BASIC. When the event occurs, the procedural code is interrupted, and the interrupt handler takes over. Your program must use Windows-aware functions to give the events a chance to occur. The effect is similar to a pure event-driven model, but the details seem a bit odd at first.

Although GFA-BASIC gives you direct access to the Windows API, it can actually make the programming task harder, because you have to know a lot about Windows. Because I was already familiar with the API calls, I was able to flip through the manual and find what I needed. But a novice Windows programmer may have some difficulty.

The biggest problems with GFA-BASIC are cosmetic. The editor's menu functions are not where Windows users expect to find them. The keyboard interface to the editor held true to the WordStar keystrokes but acted inconsistently with regard to block movement. The most glaring gaff is the drag-copy-paste method so often used in Windows to move large blocks of text. When you drag to the bottom of the screen, the screen should scroll and continue the selection. It doesn't.

This package can be improved by cleaning up the inconsistencies of the editor and the RCS, adding more cross-references to the documentation, and including better font support to the RCS on a control-by-control basis.

Microsoft's Visual Basic 1.0

It's no surprise that the folks who wrote Windows have remained faithful to the object-oriented, event-driven programming model with their BASIC package. Of the three packages, Visual Basic offers the cleanest set of programming tools and environments. You start your program by designing the screens first (see screen 3). Once you create what the user will see, designing the code to interact with the screens is much simpler. Doing the screens first also helps provide a structure to build

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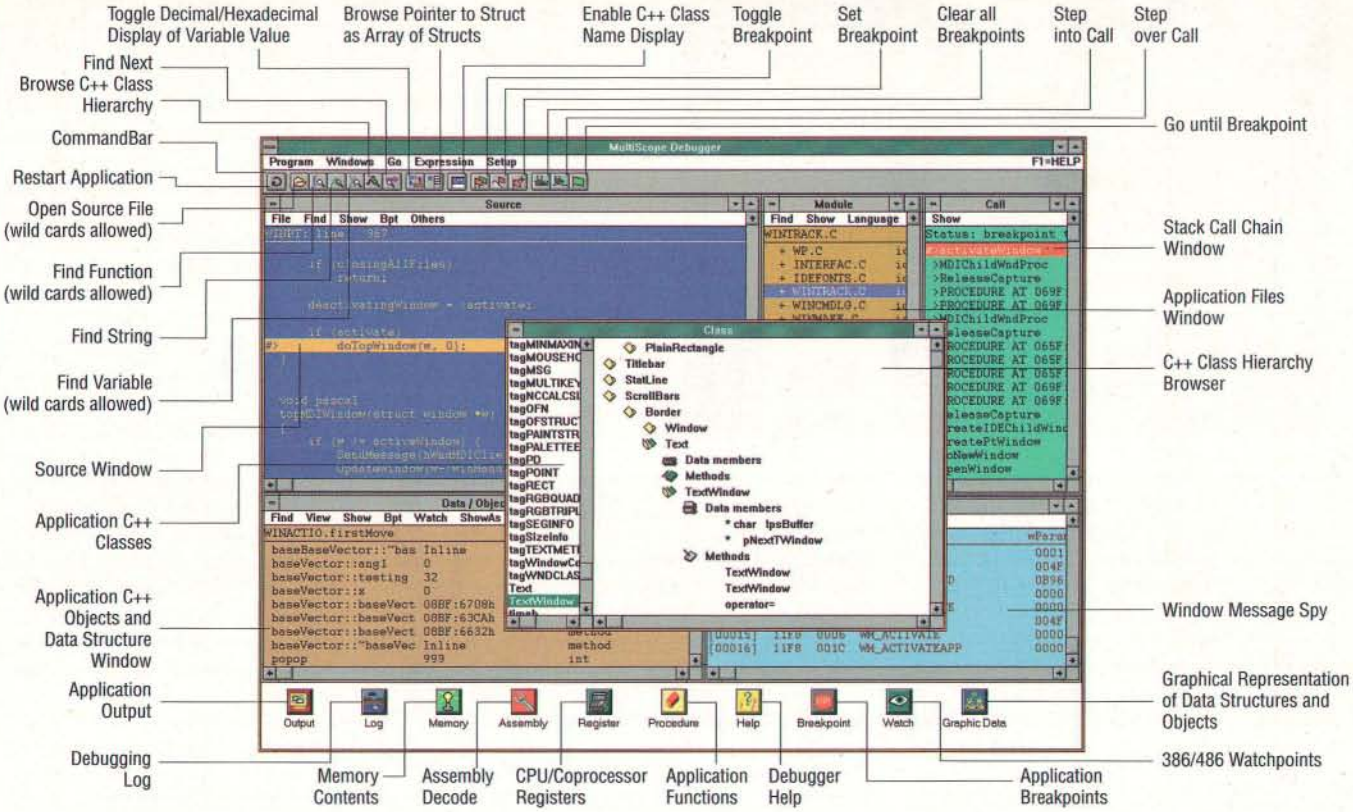

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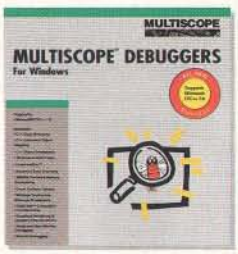

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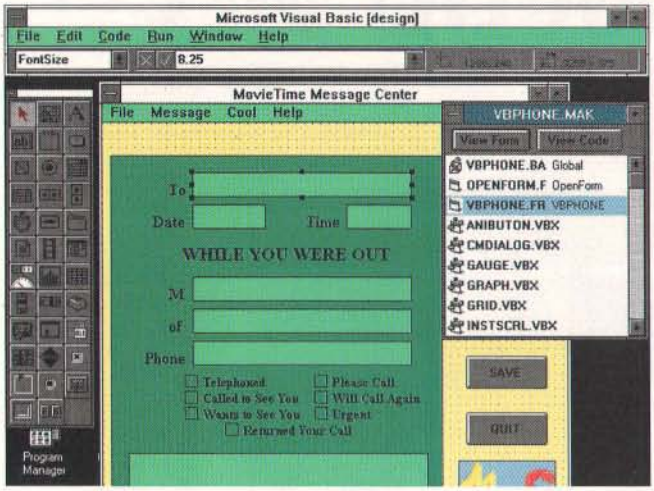

Screen 3: *Of the three packages reviewed here, Visual Basic offers the cleanest set of programming tools and environments.*

your event-driven Windows application. Visual Basic takes care of all the Windows-specific calls to the form objects and allows the programmer to concentrate on the task at hand: producing the important underlying application.

Visual Basic's forms-design tools are similar to those of the other two packages. A toolbox gives a selection of controls and buttons that you simply click on and drag to place on your form. Compared to the others, Visual Basic offers a better selection of control objects and generally handles them in a more consistent manner. The Professional Toolkit gives added zing to any application by offering a more exotic variety of control objects. Control objects can have English names for easier referencing within your program.

Writing code is simple. Just double-click on any control object within the form editor and bring up a text editor with a skeleton subroutine. There is a drop-down selection within this editor that allows you to define what event you want to write a handler for.

The Professional Toolkit is a collection of custom controls that load as extensions to Visual Basic. They become part of the toolbox and are used in the same manner as any other control when designing the form. Some of these controls are 3-D buttons, 3-D checkboxes, animated buttons, common dialogs, and graphs. Visual Basic also provides a Control Development Kit and documentation on how to develop your own custom controls (i.e., DLLs that are written to work specifically with Visual Basic). However, this requires a working knowledge of C and a thorough knowledge of Windows concepts and the SDK.

Microsoft provides a variety of help systems to guide those who need a better understanding of the workings of the APIs. There is also a collection of articles dealing with various subjects related to Windows, APIs, and Visual Basic. The help system within this package provides excellent suggestions and examples of the workings of the system. Both novice and experienced programmers will find something of value in the help files.

There is no direct Windows API support. If you want to do something with Windows that you can't do with the standard Visual Basic functions, you'll have to write a DLL. The linkage is there, but most users will not have to venture far from the standard and custom controls already provided. Should you choose to stray into the magical realm of DLLs, be prepared with a C compiler, the SDK, and a good working knowledge of the Windows API.

Creating the code for my message database was easy using standard BASIC commands. The application was up and running within a few hours of my loading the program. Visual Basic took care of all the Windows stuff; I had to concentrate only on getting the information from the screen fields and accessing the database on disk. I found the editor functions quite intuitive, although the editor displayed only one subroutine at a time. That turned out not to be a problem, as moving from procedure to procedure was fast and easy. I didn't notice any problems with performance. Visual Basic usually gets a bad rap for being somewhat sluggish, but I was working on a fast machine and my application was relatively simple. Your mileage may vary.

A BASIC Decision

Someone who knows a structured language such as dBase or Lotus macro programming would find CA-Realizer a suitable choice. It provides a layer of protection from the API while maintaining a rich language set. Novice BASIC programmers will appreciate Realizer's good on-line tutorials.

If you understand how event-driven programming works, you'll find Visual Basic an easy way to get a program written quickly. Even if the idea of event-driven programming puts you off, take a look at Visual Basic anyway. The help system and programming examples should help you figure it out.

I appreciated the rich language set and built-in API support in GFA-BASIC, but I would have found the package more useful if it provided a command-line compiler instead of the integrated environment. The text and resource editors were just too inconsistent to use. [Editor's note: *GFA Software Technologies is currently beta-testing a true compiler for GFA-BASIC. The compiler will allow you to create DLLs and stand-alone .EXE files just as you would if you were programming in C. That's a development worth watching.*]

Of the three packages, I preferred Visual Basic. The design tools were superior to the others and felt the most like other Windows applications. It makes sense that if your design tools adhere to the Windows style, the resulting code is more likely to as well. ■

Mike Wiggins was a founding member of Multimate International and currently operates a computer consulting firm in South Windsor, Connecticut. He can be reached on BIX c/o "editors."

COMPANY INFORMATION

Computer Associates
(CA-Realizer 1.0)
1 Computer Associates Plaza
Islandia, NY 11788
(516) 342-5224
fax: (516) 342-5329
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GFA Software Technologies, Inc.
(GFA-BASIC 4.10
for Windows)
27 Congress St.
Salem, MA 01970
(800) 766-6432
(508) 744-0201
fax: (508) 744-8041
Circle 1230 on Inquiry Card.

Microsoft Corp.
(Visual Basic 1.0)
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HARDWARE

Clocking the Fastest PCs on the Planet

STEVE APIKI

Intel's 66-MHz 486DX2 kicks in the afterburner for users tired of sluggish performance in complex applications or mired in high-overhead environments like Windows and OS/2. The clock-doubling DX2, which runs internally at 66 MHz in 33-MHz systems, offers a simple way for system vendors to revitalize 33-MHz 486DX and board-upgradable designs.

I compared four of the fastest PCs ever introduced: high-performance DX2/66 systems from ALR, Compaq, Dell, and NEC. BYTE Lab benchmark results appear in the figure on page 206 and configuration details are listed in the table on page 208. Each system, designed for modularity, is a board-level upgrade of an existing machine.

ALR Flyer 32LCT

ALR's DX2/66 system consists of a new processor card installed in the company's low-cost ISA tower. The Flyer's tower configuration makes it the most expandable system in the group, with a generous 12 drive bays and 10 slots. However, choosing the $5188 Flyer will mean compromising on a few features, like a 32-bit expansion bus (the Flyer is the only non-EISA system) and a flat-screen 15-inch monitor, which you'd get with the other systems I reviewed.

In addition to the 10 ISA slots, ALR puts system RAM and Western Digital 90C30-based Super VGA on the motherboard. A cached Ultrastor IDE controller takes up one slot. The processor fits on a daughtercard that mounts into one of two proprietary 32-bit slots. The second slot can be left empty, or you can install an optional ($395) 256-KB cache module.

I benchmarked the Flyer both with and without the optional cache for comparison, but only the cached results appear in the benchmark figure. On the BYTE Lab's CPU test, the Flyer performed about 26 percent slower without the cache; on DOS and Windows applications, the difference was about 20 percent. In any case, I strongly recommend that you buy the cache option if you choose the Flyer.

Compaq Deskpro 66M

Up to this point, the fastest machine BYTE had tested was the Compaq Deskpro 486/50L. Despite the disadvantage of its 33-MHz external bus versus the full 50-MHz architecture of the 486/50L, the Deskpro 66M runs faster. It outscored the older Deskpro on our application tests, which are sensitive to I/O speed as well as raw processing power.

The Deskpro also outstripped the other DX2/66s on application tests, although the Dell 466DE was faster on pure CPU tests. The fast 510-MB hard drive was obviously a strong contributor to applications performance, but Compaq's fast QVision graphics system also played a role.

The 32-bit QVision board is the only card that takes up one of the Deskpro's EISA slots. Processor and memory-expansion cards fit in their own proprietary slots, and IDE and floppy drive controllers are on an I/O board that mounts under the power supply.

With a 15-inch QVision flat-screen monitor, the system sells for $6995—considerably higher than the rest. However, the Deskpro includes more memory and a larger hard drive than all but the PowerMate. Including these features, and considering street-price versus list-price differentials, the Deskpro 66M is a very attractive choice.

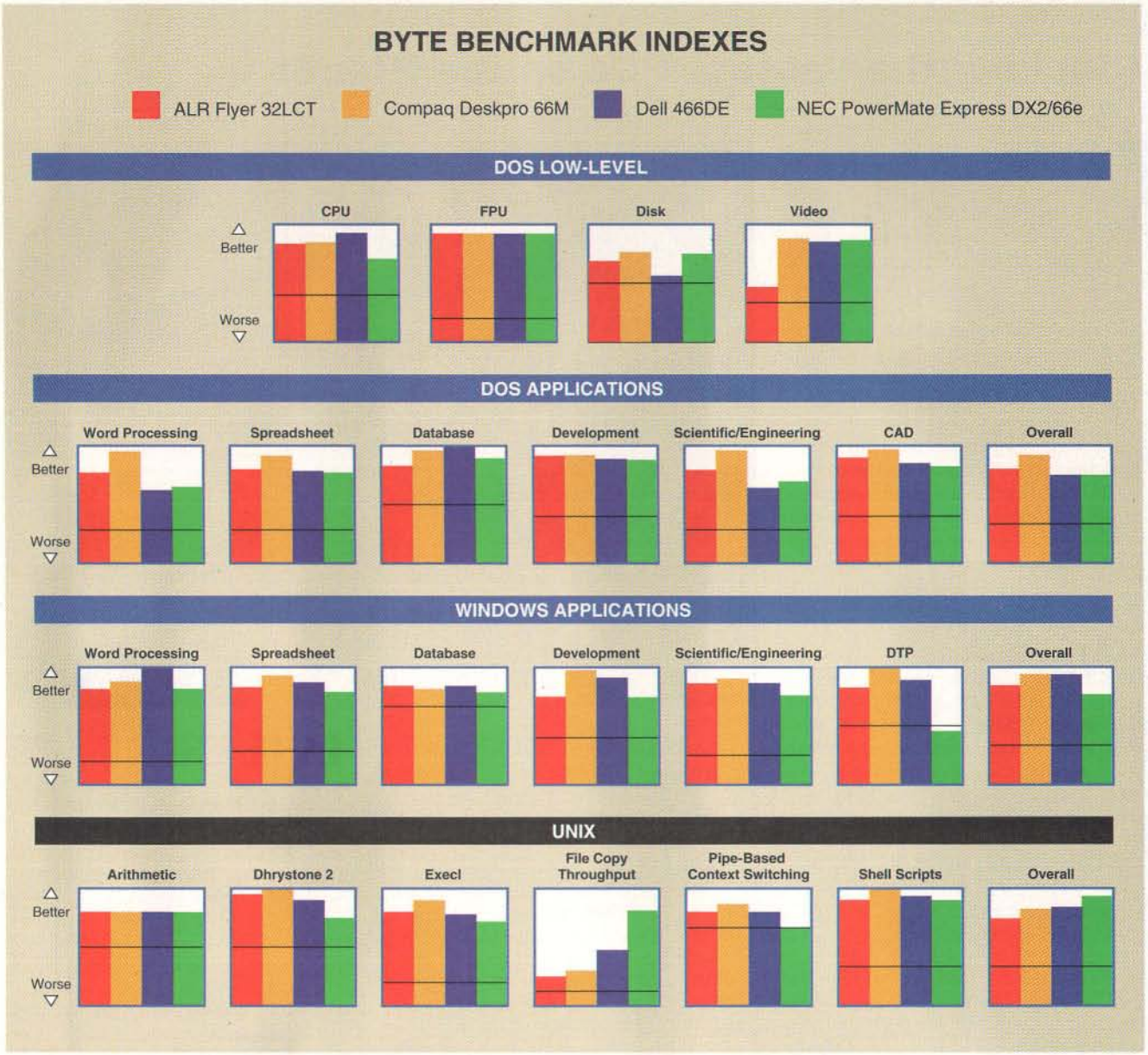
Dell 466DE

The $3869 466DE split most of the performance benchmarks with the Deskpro 66M. Although its lackluster drive held it back on DOS application tests, the 466DE earned the highest CPU index we've seen to date, well ahead of the rest of the 66-MHz pack.

Dell's newest upgradable desktop unit

BYTE ACTION SUMMARY

- **WHAT 486DX2/66 SYSTEMS ARE**
  Machines built around Intel's 66-MHz 486DX2, a 32-bit processor that runs at 66 MHz internally and 33 MHz externally.
- **LIKES**
  These are the fastest Intel systems to date; graphics optimizations make systems exceptionally quick to respond.
- **DISLIKES**
  Considerably more expensive than 33-MHz 486DX systems.
- **RECOMMENDATIONS**
  Benchmark results split top performance ratings between the Deskpro 66M and Dell 466DE.



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. For each index in the Unix tests, a Sun Sparcstation IPC = 1. The overall index is the average index of the individual tests.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test six application categories for each environment, running test scripts using WordPerfect 5.1 and Lotus Ami Pro 2.0 for word processing tests; Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a for spreadsheet tests; Software Publishing Superbase 4 version 1.3 and Borland dBase IV for database tests; Borland Turbo Pascal for Windows and Microsoft C 6.0 for development; MathSoft Mathcad for Windows 3.0, The MathWorks MatLab 3.5k, and Computing Resource Center Biturbo Stata 2.1 for scientific/engineering; Autodesk AutoCAD release 11 for CAD; and Aldus PageMaker 4.0 for desktop publishing. The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (execl()), file copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, in the listings area on BIX, or on disk.

Dell's 466DE shows a slight advantage on BYTE's low-level CPU benchmark, but the difference evaporates against the Deskpro 66M's faster hard drive when running real DOS applications. Accelerated graphics tie the Compaq and Dell systems running Windows applications, while the PowerMate's fast SCSI drive pushes it past the other systems on Unix.

includes an ATI Ultra Super VGA on an expansion card, favoring it over the VGA built into the motherboard in previous designs. The Ultra, coupled with the 66-MHz DX2 processor, delivers absolutely astounding Windows performance. The 466DE virtually tied the Deskpro 66M on Windows applications with this advantage.

The Ultra fits in a half-length EISA slot; the half-length processor module sits in a proprietary slot behind it. That leaves four slots for additional expansion. For such a compact case, the 466DE allows a lot of room for growth; Dell also includes a dual

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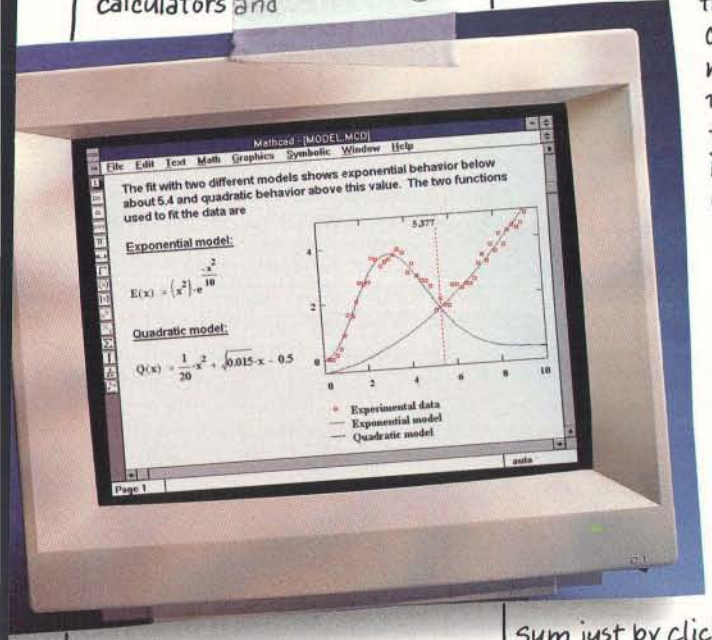

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DX2/66 SYSTEM FEATURES

Each of these systems includes performance features like controller cache and high-speed video, but differences in disk capacity and memory configuration make direct price comparisons difficult.

	ALR Flyer 32LCT	Compaq Deskpro 66M	Dell 466DE	NEC PowerMate Express DX2/66e
Price (as tested)[1]	$5188	$6995	$3869	$5948
Processor	i486DX2/66	i486DX2/66	i486DX2/66	i486DX2/66
RAM				
As tested (MB)	8	16	8	8
Max. on-board (MB)	64	64	96	256
Second-level cache				
Size (KB)	256	256	128	128
Hard drive				
Capacity (MB)	340	510	120	535
Interface	IDE	IDE	IDE	SCSI
Controller cache (KB)	512	0	256	0
Floppy drives (MB)	1.44	1.44 /1.2	1.44 /1.2	1.44
Video				
Maximum resolution (pixels)	1024 × 768, 256 colors	1024 × 768, 256 colors	1280 × 1024, 16 colors	1280 × 1024, 16 colors
256-color resolution	1024 × 768	1024 × 768	1024 × 768	1024 × 768
Video RAM (MB)	1	1	1	1
Monitor	ALR FlexView 3X	QVision 150	UltraScan 15FS	NEC 4FG
Monitor size (inches)	14	15	15	15
Drive bays	12	4	5	5
Expansion slots	10 ISA	4 EISA	6 EISA	5 EISA
Power supply (W)	300	240	220	285
Other features	DOS, Windows, mouse	DOS, Business Audio, mouse	DOS, Windows, mouse	DOS, Windows, mouse

[1] As-tested price includes features listed below, including monitor.

1.44-/1.2-MB floppy drive that fits in a single half-height drive bay.

One of the weaker points in Dell's desktop systems has been its somewhat fuzzy UltraScan monitor. The review 466DE came with a Dell UltraScan 15FS, a much better, brighter, flat-screen monitor that makes the 466DE much nicer to use.

NEC PowerMate Express DX2/66e

Local-bus graphics and a fast SCSI drive are the main performance-enhancing features on the PowerMate. Coupled with its 66-MHz DX2 processor, these features make the PowerMate a very fast platform for graphics work. However, the PowerMate's somewhat underpowered processing system left it behind the rest of the systems on our DOS and Windows application tests.

The BYTE Lab's CPU benchmark rated the PowerMate lower than the other DX2/66 systems. Despite good graphics and an excellent disk score, the CPU/memory bottleneck kept NEC's machine slightly behind the leaders on the application benchmarks. However, its fast SCSI drive put it well past the others on the Unix File Copy tests, giving it the best Unix index overall.

NEC's system is roomy for a desktop unit, with plenty of space for hard drive, peripheral card, and memory expansion. The only card that used an EISA slot in my test system was a DPT SCSI controller, which had no cache as configured but which can accept several megabytes of disk cache.

The SCSI drive and controller enhanced performance, but the lack of controller cache slowed some disk-intensive applications. For example, PageMaker 4.0, part of our application suite, ran very slowly on a few operations.

With a 4FG monitor, the PowerMate DX2/66e sells for $5948. The outstanding monitor helps to make the PowerMate a great graphics platform: Its local-bus graphics system was not as fast as the accelerator-based designs under Windows, but the PowerMate's graphics solution will speed up applications with or without special drivers.

Power Quartet

These four systems represent some excellent trends: higher clock speeds, upgradable CPUs, graphics optimizations, generally good monitors, and, of course, the trend toward low cost. However, these DX2 systems are still considerably more expensive than straight 486DX/33 designs.

But if performance is what you want, you'll get a lot more for the extra money. Performance fails to differentiate the top two systems, the Compaq Deskpro 66M and the Dell 466DE; both are outstanding. Of the two, I'd narrowly choose the 466DE for its better price. ■

Steve Apiki is a BYTE technical editor with a B.S.E.E. from Rensselaer Polytechnic Institute. You can reach him on BIX as "apiki" or on the Internet at apiki@bytepb.byte.com.

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Irvine, CA 92718
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(Deskpro 66M)
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HARDWARE

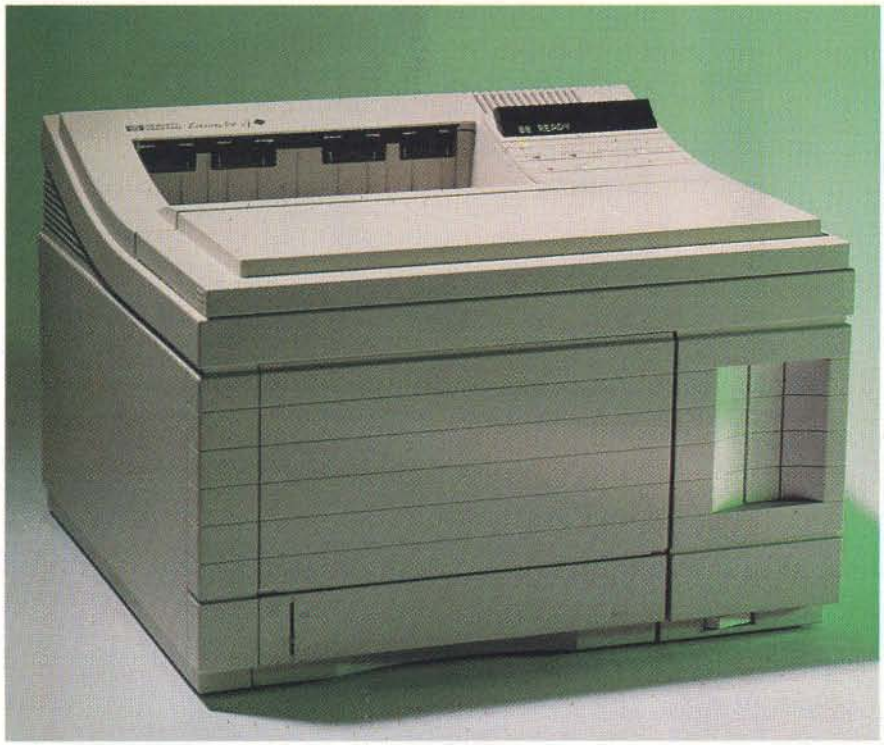
A New LaserJet, a New Standard

SHELLEY CRYAN

With its new LaserJet 4M printer, Hewlett-Packard proves a central computer industry maxim: If you wait long enough, features will soar and prices will plummet. While that's bad news if you've got money tied up in expensive, aging equipment, it's good news if you're currently in the market for a solid, feature-rich printer.

Last year, for example, 600-dot-per-inch PostScript printers fetched upward of $4000. Multiple-platform connectivity cost extra. So did automatic emulation switching and decent speed. Yet the LaserJet 4M offers all this and more for $2999.

As you might expect, this boots HP's former powerhouse, the LaserJet III, into retirement. In its place are the 4M and the upgradable LaserJet 4, which lacks PostScript and Macintosh connectivity and retails for $2199.



The LaserJet 4M from Hewlett-Packard includes built-in PostScript and AppleTalk. The new look includes a paper tray that tucks completely into the unit, a more readable control panel, and a true 600-dpi Canon engine.

New Specs

With the LaserJet 4 series printers, HP should set a new standard in desktop printing. The workhorses of the desktop set have been 300-dpi laser printers since the introduction of the original HP LaserJet in 1984. It wasn't that long ago that you had to pay $3000 for a 300-dpi PostScript printer, and HP is betting that consumers will still be willing to spend that kind of money if offered enhanced features.

The LaserJet 4M makes that gamble compelling, especially with its 600-dpi output. Seeing the higher resolution is akin to getting a stronger pair of glasses: You may have been happy with your old ones, but the new ones show you what you were missing, and you don't want to go back.

The crisp output of the LaserJet 4M owes much to HP's Resolution Enhancement Technology, introduced with the LaserJet III. This smooths the edges of letterforms and graphics and, along with smaller toner particles, boosts the apparent resolution. Photographs, shading, and hairline rules look especially sharp.

But the LaserJet's exceptional output is not merely a trick of software algorithms and toner technology. The printer is based on a new 8-page-per-minute Canon engine, the P270. The new design produces true 600-dpi output. Of course, this also means that the LaserJet 4 will not accept the old Canon toner cartridges. While the newly designed cartridges will cost more than the old cartridges ($150 as opposed to $125), they will also pump out more sheets (6000 sheets, up from 4000), resulting in lower cost per page, HP says.

Because of the LaserJet's traditional market share, you can expect immediate third-party support for the 4M. Extended Systems has already announced a family of add-on products for the LaserJet 4, including a fax module.

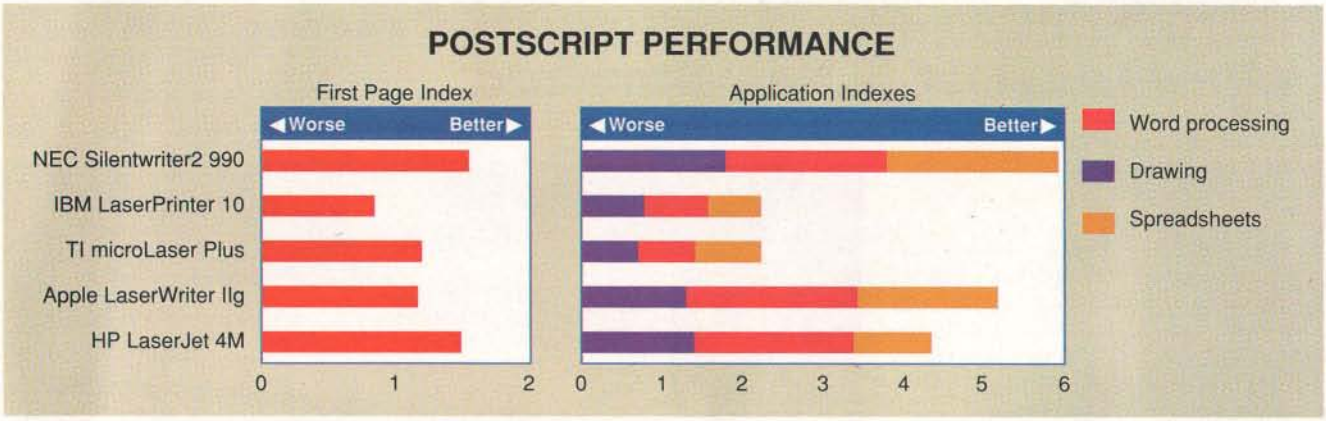
PostScript Performance

Tests prove that the 4M is indeed a respectably speedy printer. I put it through BYTE's standard suite of Genoa Technology tests, which have been run on comparable printers (see "PostScript's Middle Class," August BYTE).

In the first-page index, which measures how long it takes to print a standard business letter, the HP LaserJet 4M ranked right up there with 300-dpi printers and bested units with higher resolution (see the benchmark graph). The LaserJet 4M lagged slightly behind the NEC Silentwriter2 990 but was faster than the rest of the pack, including the 300-dpi Texas Instruments microLaser Plus, the Apple LaserWriter IIg, and the 600-dpi IBM LaserPrinter 10.

In the second set of tests, consisting of printouts from a variety of word processing, drawing, and spreadsheet applications, the LaserJet 4M finished in the middle of the pack. Of the models faster than the LaserJet 4M, however, all deliver lower resolution. When you consider that a 300-dpi printer handles only a fourth as much data as the 4M, the new LaserJet's performance is all the more notable.

A few factors account for the printer's impressive speed. Most important, the LaserJet 4M uses an Intel 960KA 20-MHz RISC processor. Additionally, the LaserJet 4M comes packaged with PostScript Level 2, which is speedier than Level 1. (The LaserJet 4 lacks PostScript but can be upgraded for $495). PostScript is built right in, so you no longer need a speed-choking cartridge, as was required for the LaserJet II and the LaserJet III. An enhanced



The performance of the LaserJet 4M is impressive, especially given its higher resolution. For other comparisons, see "PostScript's Middle Class," August BYTE.

HP PCL 5 printer control language (HP claims to have optimized the language for faster graphics performance) and a 156-KBps parallel port also contribute to its speed.

BYTE ACTION SUMMARY

- **WHAT THE LASERJET 4M IS**
  Hewlett-Packard's 600-dpi PostScript laser printer for PCs and Macs.
- **LIKES**
  The 4M provides impressive print quality at a reasonable speed. The automatic emulation switching worked flawlessly.
- **DISLIKES**
  The multipurpose tray feels rather flimsy, and its extension doesn't slide out very smoothly.
- **RECOMMENDATIONS**
  The sharp 600-dpi output sets a new standard for desktop printers. A good buy and a safe bet.
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  LaserJet 4, $2199
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Automatic Emulations

People who work in departments with both Macs and PCs will appreciate the 4M's built-in parallel, serial, and LocalTalk ports. Best of all, when you send print jobs from any source, in PostScript or PCL, the printer will automatically identify the source language and proceed with the print job. There's no need to get up and manually switch the printer yourself.

I put this feature to a rigorous test. With a 386 PC hooked to the parallel port, and a Mac IIcx on the other end of the LocalTalk cable, I repeatedly sent a barrage of alternating PostScript and PCL files. From the Mac, I sent QuarkXPress files with text and photos, as well as Aldus FreeHand drawings. The 386 sent detailed drawings from AutoSketch for Windows, as well as text-laden pages from DOS-based WordPerfect 5.1. Despite my best efforts, I was unable to trip up the printer. The automatic emulation switching worked perfectly.

Although you can expect extensive driver support for the new LaserJets, it's inevitable that not all applications will be supported by updated printer drivers. You could use LaserJet III drivers, but you may not have access to all the 4M's advanced features from your software application. HP has addressed this inconvenience in two ways.

First, the new LaserJet includes an easy-to-read, vacuum-fluorescent display on the printer's control panel, making it easier to manually select features. Second, HP's PC Remote Control Panel software greatly minimizes the need to touch the printer's front control panel. Just load this free utility and a functional representation of the control panel appears on-screen.

Paper Pusher

Gone is the protruding paper tray of LaserJets past. The new model tucks a 250-sheet tray under the printer itself. Unfortunately, that's not the case with the printer's 100-sheet multipurpose tray, where you load odd-size paper, including up to 10 envelopes at a time. When opened, this tray hangs off the front of the unit and feels rather flimsy. A built-in tray extender helps steady longer sheets of paper, but it doesn't glide in and out smoothly. It does the job, however, as envelopes fed through without a hitch.

Replacing the toner cartridge is a snap—literally. You hear a satisfying click when you slide it in correctly. A protective tape, as well as a clever overall design, makes replacing a cartridge a clean, spill-free operation. The drum and toner cartridge come packaged as a unit, so replacing one means that you have to replace the other. While this is convenient, it can also be more expensive than purchasing a drum and toner separately.

The LaserJet 4M comes standard with 6 MB of RAM, expandable to 22 MB. An optional $225 paper tray can be attached underneath to expand the paper capacity by 500 sheets. A power envelope feeder that holds 75 envelopes is available for $295. The 4M includes 10 TrueType, 35 Intellifont (HP), and 35 PostScript typefaces, as well as a cartridge slot.

If the past is any indication of the future, you'll be able to get better features at a lower price next year. But don't torture yourself. The LaserJet 4M today offers an impressive combination of features at a reasonable price. ■

Shelley Cryan runs a consulting business that helps companies incorporate computer-based technologies to boost productivity. She holds an M.B.A. in finance and marketing from the University of Chicago. She can be reached on BIX c/o "editors."

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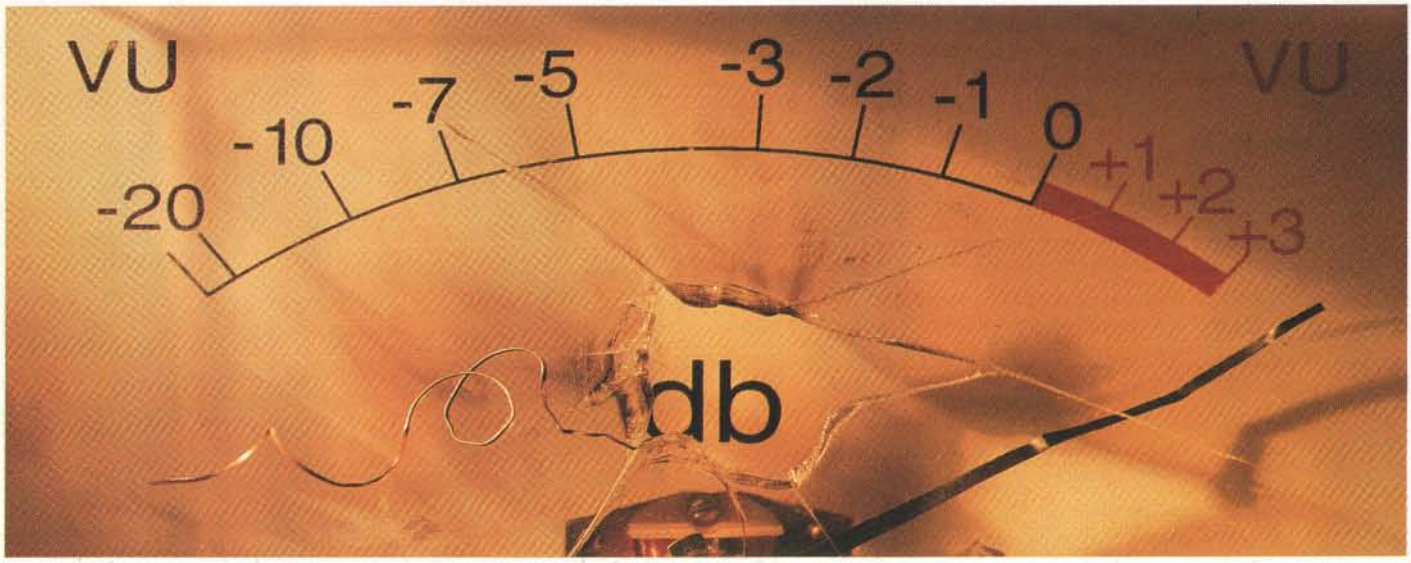

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SOFTWARE

TypeReader Takes OCR Toward Better Recognition

D. BARKER

ExperVision claims that TypeReader's OCR (optical-character-recognition) technology is "virtually" 100 percent accurate. Just think: An OCR package that can read a scanned page and correctly understand "virtually" every single character would let you drop text into your word processor or spreadsheet and not have to fix a thing.

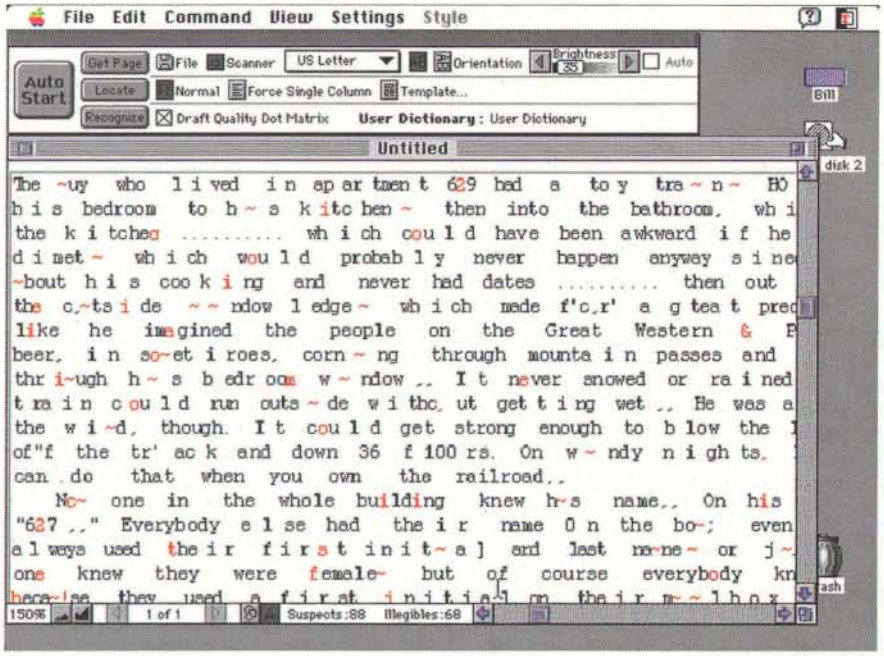
It would be great if that claim were true. But while TypeReader is more accurate than many other OCR programs on the market, its accuracy rate falls short of perfection, especially with second-generation documents and ornate typefaces. However, with clean, laser-printed output, TypeReader's accuracy is the closest I've seen yet to 100 percent.

TypeReader, available in Macintosh and Windows versions, uses what ExperVision calls machine-learned fragment analysis. Other programs, like Caere's OmniPage and Calera's WordScan, use feature extraction. They look at each text character and identify features such as lines and loops, and then they use that information to try to deduce what the letter is. They know that a letter composed of a vertical stroke and three parallel horizontal strokes appended to it is probably an *E*.

Machine-learned fragment analysis, a pattern-recognition technology, uses geometric models. A font is a set of coordinates in that model. When the program looks at a character, it analyzes each fragment—the stroke coming out of a *d*, for example—and breaks it down into a numerical model. The program also looks at the relative lightness and darkness of a character; only the fragments that are very dark or very light are reliable indicators of what a character is. The program takes the good fragments and maps them geometrically.

Like other packages that use lexical context, the program then takes its best guess at what a word might be and checks its dictionary to see if that word is there. If it finds *jack* and not *jeck*, for instance, it figures that second letter is probably an *a* rather than an *e*. According to ExperVision, TypeReader algorithms consist of code to *learn* to recognize characters rather than code to recognize characters.

Fragment analysis sounds good, but does it really make a difference? With certain types of output, it does. TypeReader proves to be excellent—virtually 100 percent accurate—at interpreting 10-point text from a daisy-wheel printer and good-quality output from a laser printer. But take that same page, fax it, and then feed it to the OCR software and the accuracy rate declines, as it would with any OCR program. The big difference with TypeReader is that the accuracy rate declines *less*.



Screen 1: *TypeReader's push-button interface is neat and straightforward. After reading a scanned page, it highlights characters it doesn't recognize.*

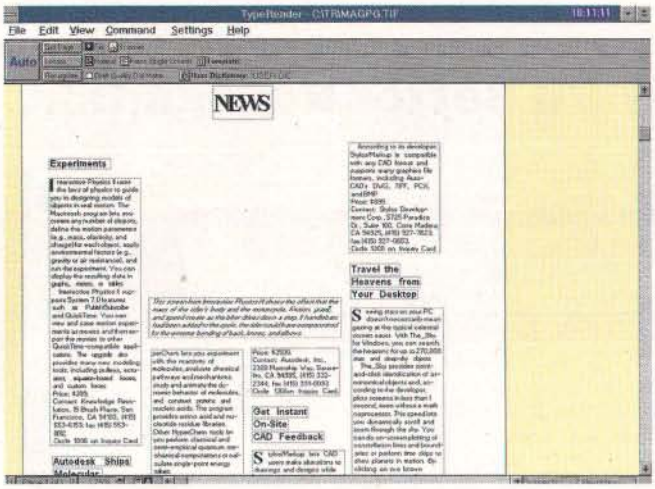
Besides its innovative OCR technology, TypeReader has other impressive attributes. The program is simple to learn and use. For basic operation, you probably won't even have to crack open the manual. The interface, very similar in both the Mac and Windows versions, is straightforward (see screen 1). All the controls you're likely to need are located on a bar along the top of the screen. The button you'll use most often, Auto, is big and obvious. Click on it and the program goes to work; it scans the page (or pages), locates all the text regions, and then starts the recognition process. It draws lines from one block to the next to show the order in which it will process the text; if you want to change that order, you can do so graphically by clicking on and dragging the lines from one region to another.

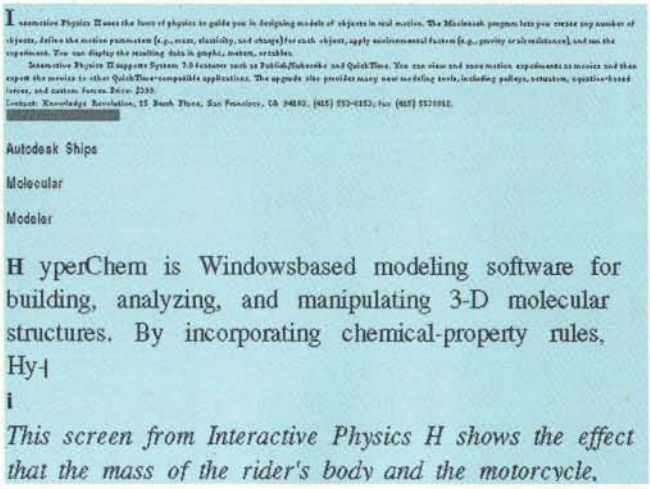
When done processing, the program displays a bit-mapped image of the page. Any characters the program doesn't understand are highlighted; any illegible characters are replaced with a tilde. You can then work through the page as you would with a word processor, jumping from suspect to suspect by pressing the Tab key and changing them if need be.

TypeReader will handle deferred processing, so you can scan in a big batch of pages, queue them up, and then have the program do its recognition chores after you've gone home. This is a nice time-saver that not all OCR packages allow.

After TypeReader has digested a scanned document, you can save it as an image or a text file. The program will export the text to any format you're likely to need, including straight ASCII and Rich Text Format, most PC and Mac word processors, and Lotus 1-2-3 and Excel. The package comes with drivers for most scanners. If you have a scanner that the program doesn't work with, you can save your scanned file in TIFF, PICT, or PCX format and then send that through TypeReader. The program can handle resolutions from 200 to 600 dots per inch.

continued





Screen 2: *TypeReader attempts to maintain the formatting of a page. But strange things sometimes happen when the scanned text is put into a word processor. Here, text from a scanned magazine page has been brought into Word for the Mac, but it doesn't always look the way it did on the scanned page. Type sizes, for example, sometimes changed.*

How Good Is It?

To test the accuracy of TypeReader, I fed it a 17-page document, output from a variety of devices: laser printer, daisy-wheel printer, dot-matrix printer, photocopier, and fax machine. Once the scanned text was saved as an ASCII file, I ran that file through a custom comparison program developed by the BYTE Lab (see "Tame the Paper Tiger," April 1991 BYTE). The program compares the original ASCII text to the OCRed version and generates a report showing every error and the overall accuracy rate. The BYTE comparison program counts wrong words rather than wrong characters (the latter approach is what most OCR vendors use in arriving at their accuracy claims). Words, rather than individual characters, are a more meaningful index. Words are the standard currency of communication, and if you take an OCRed document and run it through a spelling checker, it will look for suspect words rather than incorrect characters.

Given a page of Courier text from a daisy-wheel printer set at 10 characters per inch, TypeReader's accuracy rate is an impressive 99.4 percent. This kind of output is an OCR program's dream, however. What happens when the type isn't so clean? When that same document was faxed, the accuracy rate fell to 93.1 percent. The photocopied version was worse, turning in an accuracy rate of 91.1. The program handled a light but fairly typical dot-matrix document with considerable aplomb, yielding an accuracy rate of 92.1 percent. In our tests, TypeReader registered its best score with a laser-printed document set in 12-point Palatino. The accuracy rate was 99.9 percent. Most excellent.

While anything near 90 percent is a great score in most situations, it's not such a good batting average for an OCR program. Look at it this way: A 99 percent accuracy rate means one wrong word out of every 100.

All these tests were run at the program's default settings. You can adjust the scanner's brightness levels within TypeReader. Getting the right brightness level results in a more accurate reading. After I raised the brightness used to scan a faxed page, the accuracy rate changed from 93.1 percent to 95.3 percent.

TypeReader consistently scored higher in our accuracy tests than almost any other OCR software the BYTE Lab has reviewed. The only program to top it, and that was only in the daisy-wheel test, was Calera's WordScan Plus, which scored 99.6 percent compared to TypeReader's 99.4 percent. The runners-up were Caere's OmniPage, at 99.3, and Hewlett-Packard's AccuScan, at 99.2 percent. In the other tests, TypeReader was a clear winner. The nearest competitor in the laser-print test was OmniPage, which scored 97.2 percent compared to TypeReader's 99.9. In the rest of the tests, no package came close to TypeReader's accuracy ranking. With the dot-matrix document, the closest score was OmniPage's 88.9.

Reading Ransom Notes

ExperVision says TypeReader can handle any type size from 5-point to 64-point. Six-point type is what most other programs claim as the smallest they can read, and anywhere from 26 to 72 (OmniPage) as the largest. In order to check the program's ability to handle multiple point sizes and fonts—the company says the package can understand 1700 typefaces—I gave it the ransom-note test: a page of mixed typefaces in randomly selected sizes, from 5

BYTE ACTION SUMMARY

- **WHAT TYPEREADER IS**
  An OCR program for the Macintosh and PCs running Windows.
- **LIKES**
  Highly accurate when reading daisy-wheel and laser-printed text; good interface; deferred processing.
- **DISLIKES**
  Unacceptable rate of error when reading some second-generation documents.
- **RECOMMENDATIONS**
  This is a good OCR program that's more accurate than many and no less accurate than any other.
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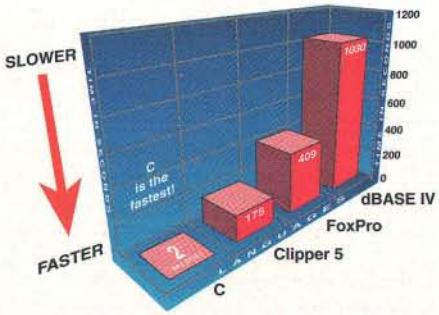

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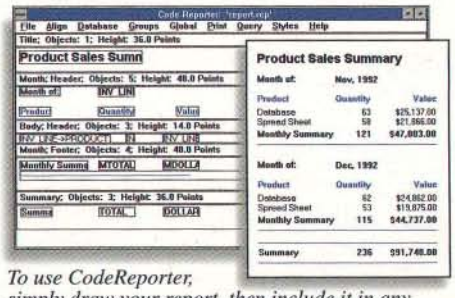

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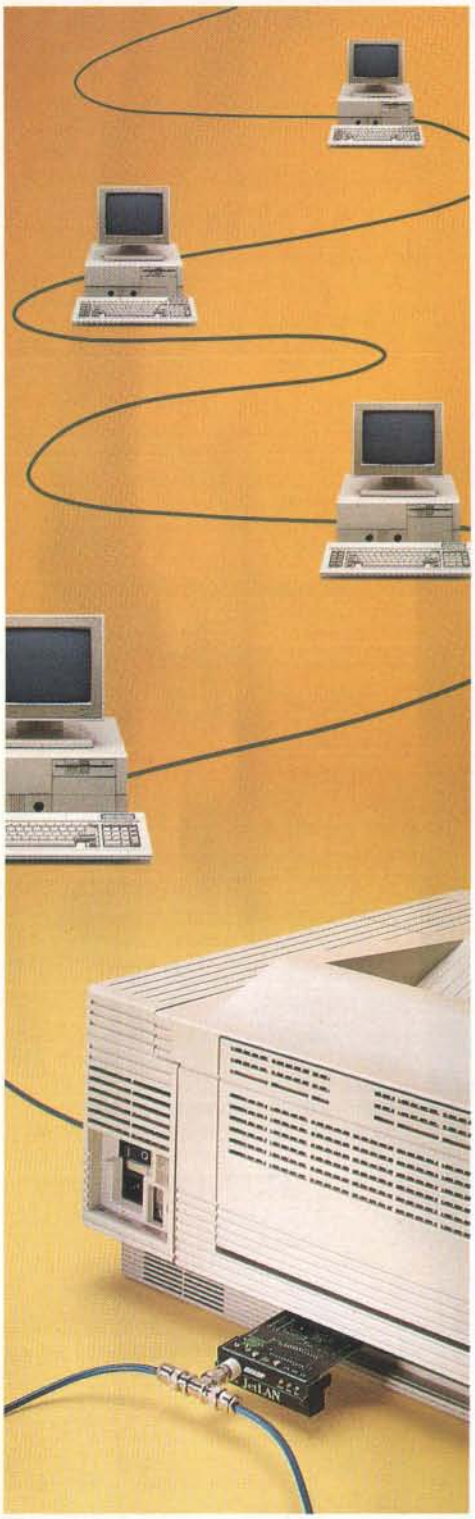

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to 64 points. TypeReader does remarkably well with Courier and Times at very small sizes. Other fonts, such as Geneva, give the program some trouble when tiny; it read a Geneva 5 as an *S*, which is understandable enough, and *point* as *peint*, which is not too far off but makes you wonder about the lexicon (since there is no English word *peint*). But in a total miss, it interpreted *line* as *M / ae*. This is disappointing, considering that Geneva isn't exactly an ornate typeface.

If you raise the type size to 7 points, TypeReader does much better, although it isn't completely accurate. In one line of 7-point text, it mistook an *M* for a *4*, resulting in a score of one wrong character out of 28. The program also chokes on big type sometimes. For example, it thought a 24-point Times Roman *n* was a *b* and guessed that the word was *ib*.

I know of no other OCR package that can do any better with very small type. TypeReader does remarkably well, but ExperVision does claim it can handle 5-point text, and that claim, as our tests prove, is not completely accurate.

TypeReader aims to preserve the formatting of a document when poured into another program. To test this, I scanned in some multicolumn pages from magazines, saved the text, and opened them up in different word processors. For the most part, styles and layouts were intact (see screen 2). The software ignores any graphics on the page. The Mac version does a better job retaining format information. It correctly interpreted drop caps (large capital letters at the beginning of a column), while they sometimes mysteriously disappeared in the Windows version. Still, problems surfaced between the conversion from bit-mapped to word processor file. Some lines turned to gibberish.

Nobody's Perfect

An OCR program has to be at least as accurate as a good typist to be worth its price. With clean output and simple typefaces, TypeReader is accurate enough to make the grade. By surpassing the 99 percent accuracy rate when handling daisy-wheel and laser output, it earns high marks. And you can yield a higher accuracy rate by learning which settings work best.

Some OCR developers say total accuracy will never be attained; some say it will take something like neural networks to make the programs smarter. TypeReader isn't perfect, but in the evolution of OCR, it's a big step toward perfection. ■

D. Barker is a BYTE Lab editor covering applications software. You can reach him on BIX as "dbarker."

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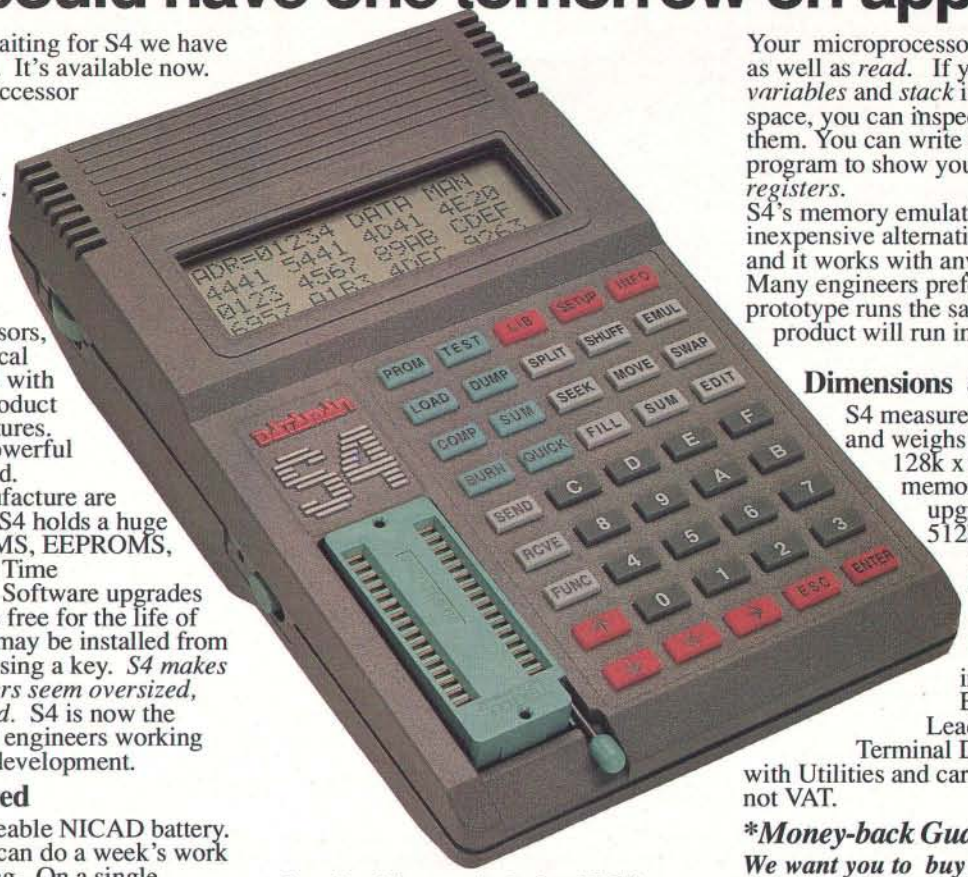
Dataman's new S4 programmer costs £495
You could have one tomorrow on approval*

If you've been waiting for S4 we have some good news. It's available now. S4 is the 1992 successor to Dataman's S3 programmer, which was launched in 1987. The range goes back through S2, in 1982, to the original Softy created in 1978. Like its predecessors, Softy4 is a practical and versatile tool with emulation and product development features. S4 is portable, powerful and self-contained. Design and manufacture are State of the Art. S4 holds a huge library of EPROMS, EEPROMS, FLASH and One Time Programmables. Software upgrades to the Library are free for the life of the product, and may be installed from a PROM by pressing a key. *S4 makes other programmers seem oversized, slow and outdated.* S4 is now the preferred tool for engineers working on microsystem development.



Battery Powered

S4 has a rechargeable NICAD battery. On average, you can do a week's work without recharging. On a single charge, up to a thousand PROMS can be programmed – and charging is fast: it only takes an hour. Normal operation can continue during the charging process.

Continuous Memory

Continuous Memory means never losing your Data, Configuration or Device Library. You can pick up S4 and carry on where you left off, even after a year on the shelf. If the NICAD battery loses all of its charge, RAM contents are preserved by the LITHIUM backup battery.

Remote Control

S4 can be operated via it's RS232 Serial Port. The standard D25 socket connects to your computer. Using batch files or a terminal program, all functions are available from your PC keyboard and screen.

Free Terminal Program

You could use any communications software to talk to S4. But the Terminal Driver program, which we include free, is the best choice. It has Help Screens to explain S4's functions and it sends and receives at up to 115200 baud – that's twelve times as fast as 9600 baud. At this speed a 64 kilobyte file downloads in 9 seconds. There is a memory resident (TSR) option too, which uses only 6k of your precious memory, and lets you "hot key" a file to S4. Standard *upload* and *download* formats include: ASCII, BINARY, INTELHEX, MOTOROLA and TEKHEX.

S4 loads its Library of programmables from a PROM in its socket, like a computer loads data from disk. Software upgrades are available free. Download the latest Device Library from our Bulletin Board.

Microsystem Development

With S4 you can develop and debug microsystems using Memory Emulation. This is an extension of ROM emulation, used for prototype development, especially useful for single-chip "piggy back" micros. When you unpack your S4 you will find an Emulator Lead with a 24/28/32 pin DIL plug and a Write Lead with a microhook. Plug the EMULead in place of your ROM. Hook the Write-Lead to your microprocessor's write-line. Download your assembled code into S4. Press the EMULate key and your prototype runs the program. S4 can look like ROM or RAM, up to 512K bytes, to your target system. Access-time depends on S4's RAM. We are currently shipping 85ns parts.

Your microprocessor can *write* to S4 as well as *read*. If you put your *variables* and *stack* in S4's memory space, you can inspect and edit them. You can write a short monitor program to show your *internal registers*.
S4's memory emulation is an inexpensive alternative to a full MDS and it works with any microprocessor. Many engineers prefer it because their prototype runs the same code that their product will run in the real world.

Dimensions & Options

S4 measures 18 x 11 x 4 cm and weighs 520 grams. 128k x 8 (1MB) of user memory is standard, but upgrading to 512k x 8 is as easy as plugging in a 4MB low-power static CMOS RAM.
The stated price includes Charger, EMUlead, Write Lead, Library ROM, Terminal Driver Software with Utilities and carriage in U.K. but not VAT.

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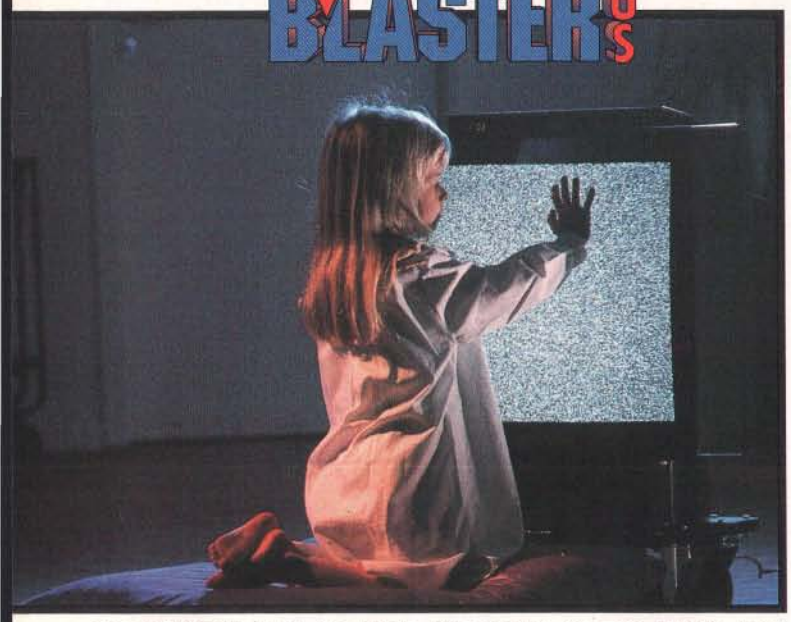

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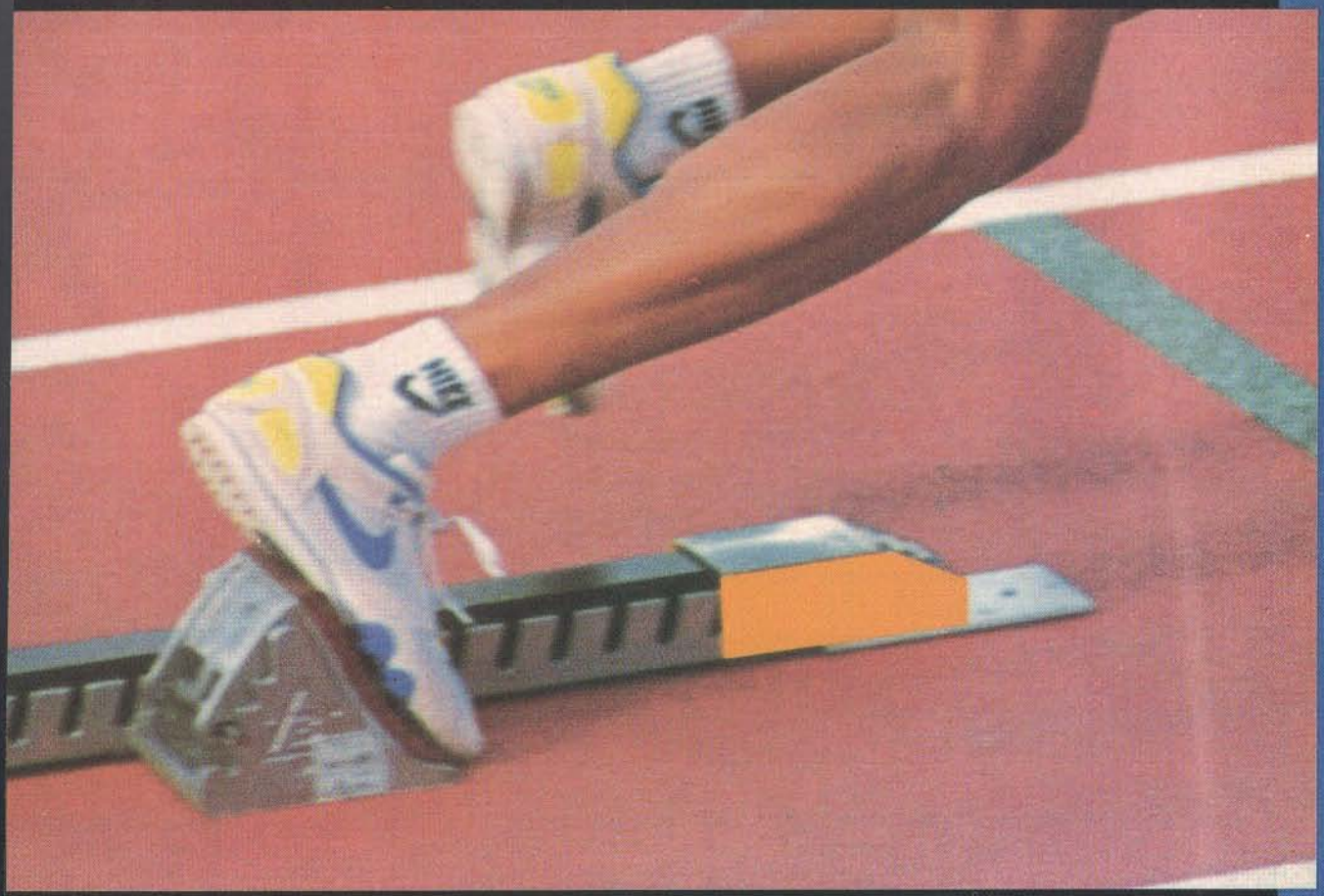

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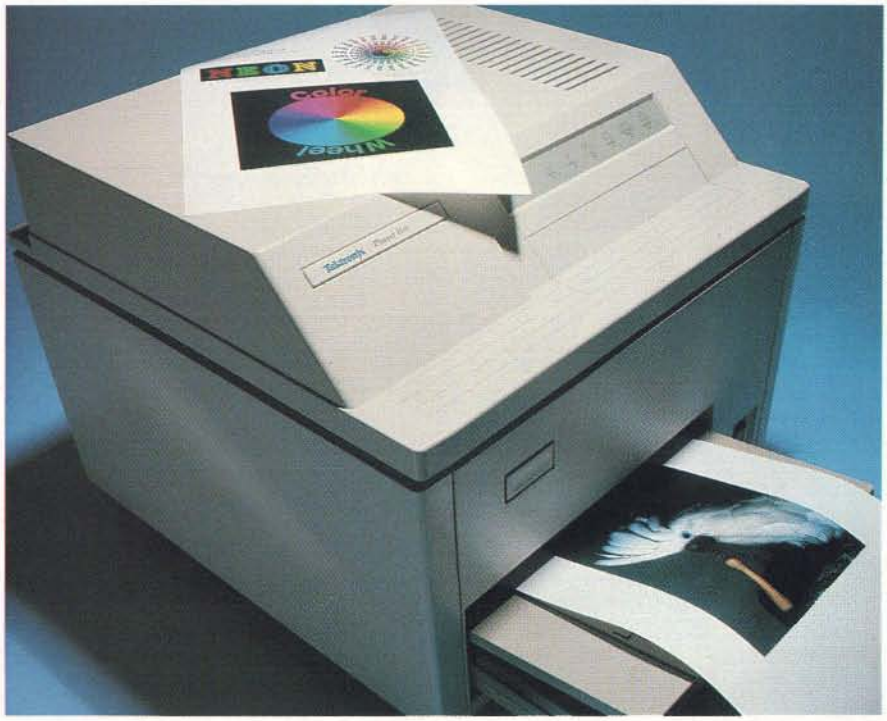
HARDWARE

The Phaser II SD Prints Dazzling Dyes

TOM THOMPSON

Why are professional graphic artists so excited about dye-sublimation printers? One color printout tells the story. Instead of using halftoning or dithering processes to create colors on paper, a dye-sublimation printer uses heated dyes that diffuse into a special paper and mix to form continuous-tone color images. The output has a near-photographic color quality and appearance (see the photo on page 219).

Of course, you pay for the quality, but the costs are coming down. Currently, prices start at about $15,000 for the printers, and the output costs $5 to $10 per page. Tektronix's Phaser II SD is a 300-dot-per-inch dye-sublimation color printer that costs $10,000; the cost per page is roughly $3.



The Tektronix Phaser II SD: A dye-sublimation process creates near-photographic output for roughly $3 per page.

Interiors

The Phaser II SD looks remarkably similar to the Phaser II PXi thermal-wax printer, and for a reason: It borrows heavily from the PXi's proven thermal-wax design. Inside the Phaser II SD, a transfer roll impregnated with three or four process colors moves past a printer head embedded with heating elements. When hot, these elements flash the solid dyes into vapor (the sublimation process), driving the colors onto the paper. This mechanism is similar to thermal-wax printing, but the dye chemistry, paper type, and precision control of the heating elements differ for dye-sublimation printing. For additional information on dye-sublimation technology, see "Hot Colors" in the October 1991 BYTE.

The Phaser II SD's 24-MHz AMD RISC processor powers an Adobe PostScript Level 2 interpreter. The main logic board has 16 MB of RAM mounted on it, expandable to a maximum of 64 MB. The printer's firmware has 39 resident Type 1 PostScript fonts, and a 50-pin Centronics-style SCSI port offers additional font storage on an optional hard drive.

A Sharp printer engine, built to Tektronix specifications, prints on letter (8½ by 11 inches), legal (8½ by 14 inches), A4 (200 by 238 mm), and A4 special (200 by 297 mm) paper or transparency sheets. The dye-sublimation process requires a special polyester paper. Total cost per page depends on the number of dyes used (three or four colors), the paper size (letter or legal), and the media type (paper or transparency). At the low end, a three-color letter-size paper page costs $2.75, while the cost of a four-color legal-size transparency jumps to $4.25.

The printer has several standard interfaces: DB-25 serial, Centronics parallel, and mini-DIN-8 LocalTalk. The printer firmware switches automatically among the ports as jobs are sent to it by various computers.

For those folks who need to print multimegabyte image files, an optional Ethernet interface board ($695) that boosts throughput plugs into a socket on the logic board. On the outside, the Ethernet interface uses Apple's AUI (Attachment Unit Interface) port, which lets you connect the appropriate Ethernet transceiver to match your office network cables. This Ethernet interface supports AppleTalk Phase 2 protocols, allowing the printer to communicate on large networks. On the downside, AppleTalk is the only protocol this interface supports. Unix users will need a Tektronix 4511A network interface unit ($1495) to provide TCP/IP support or will have to use AppleTalk drivers on their workstations to print to the Phaser II SD.

Putting It to Work

The BYTE Lab tested a Phaser II SD with 48 MB of RAM and a 110-volt, 60-Hz power supply. Printers are available for countries that use different line voltages and frequencies. Unfortunately, I discovered that adding the Ethernet interface board (or extra RAM) isn't as convenient as the presence of SIMM sockets implies. It's definitely not a user-installable project: You loosen several sets of screws at the top and bottom of the printer's cover to remove it, unplug a cable, and unhook the RF shield to get at the logic board. This seems unnecessarily complicated (especially in contrast to the Phaser II PXi, where two thumbscrews release a plate on the printer cover's back).

The bundled software includes drivers and printer utilities for Windows 3.0 and the Macintosh, along with software for Sun Sparcstations. For printer timing tests, I used a Mac Quadra 950 (running System 7.0.1) on a "network" composed of just the computer and the printer. I also

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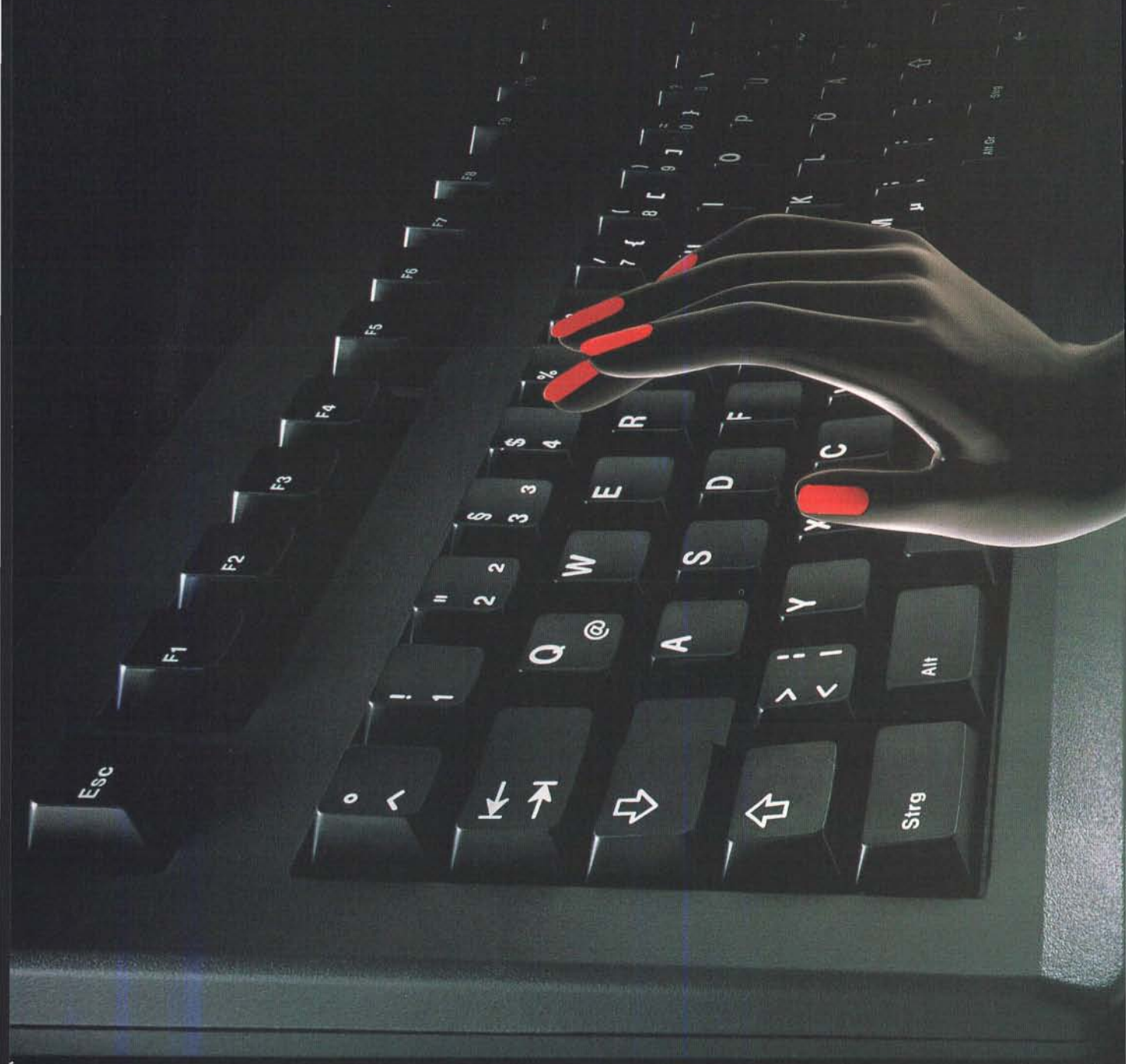

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This image was acquired using the Kodak DCS 200ci camera. On the left is a sample of the Phaser II SD's output. On the right is a thermal-wax print made from the same image data. (Photo courtesy of Howard Eglowstein)

BYTE ACTION SUMMARY

- **WHAT THE PHASER II SD IS**
  A continuous-tone, dye-sublimation color printer with PostScript Level 2.
- **LIKES**
  Near-photographic-quality output for scanned images; printer firmware produces crisp edges on text and PostScript graphics.
- **DISLIKES**
  It's difficult to add RAM or an Ethernet interface; no TCP/IP support for Ethernet.
- **RECOMMENDATIONS**
  Good for those who output scanned images or work with graphics that use many color blends or gradations.
- **PRICE**
  $9995 (includes 16 MB of RAM)
  Ethernet interface, $695
  4-MB RAM SIMM, $595
  16-MB RAM SIMM, $1995
- **FOR MORE INFORMATION**
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  Wilsonville, OR 97070
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printed with a Compaq LTE Lite/25 (in Windows 3.1) connected to the printer's parallel port.

The BYTE PostScript benchmark test, which uses several color operators to time the PostScript interpreter's color-imaging speed, posted a time of 22 seconds, making it one of the fastest interpreters on the market. (See "Color at a Reasonable Price" in the June BYTE for comparative times of thermal-wax-transfer color printers.) This value varied upward by as much as 20 seconds, depending on the printer mode.

Printing a 3.7-MB scanned image from Adobe Photoshop required 671 seconds through the LocalTalk interface, of which 218 seconds were spent by the print engine using a three-color roll to output the image. Using the Ethernet interface trimmed the output time to a total of 419 seconds. That's barely half the time taken by printing via the LocalTalk port.

At Tektronix's suggestion, I printed images to PostScript files and downloaded them to the printer. Using the Ethernet interface this way to print huge TIFF images, I cut printing times by one-third or one-fourth the LocalTalk printing times. Printing directly from an application causes poor Ethernet performance, because the data is processed before being sent to the printer.

Outstanding Output

I got marvelous output from this printer. I got rich blacks with just the three-color transfer roll, where the blacks are reconstituted by mixing the cyan, magenta, and yellow dyes. Scanned images that were printed from either Adobe Photoshop on the Mac or Aldus PhotoStyler on the Compaq notebook resembled photographs (see the photo).

The best results occurred when I set Photoshop to convert the images to the CMYK color model and used SWOP (Specifications Web Offset Publications) coated paper for the ink settings. Also, I disabled the halftoning screens, because, as a continuous-tone device, the Phaser II SD doesn't need them.

Because the dye mixing occurs inside the paper, these images are permanent and won't scratch or flake like thermal-wax materials that just adhere to the paper's surface. I had access to Kodak's DCS 200ci electronic camera and used a Photoshop plug-in to download images from it into the Quadra. From there, I made color adjustments and created a photo-quality print in a matter of minutes. Imaging technology hasn't replaced film yet, but a system comprising the Kodak DCS 200ci, a Quadra 950, and the Phaser II SD comes close.

continued

1	Exxon	25	Standard Oil (Ohio)	49	Consolidated Foods
2	General Motors	26	AT&T Technologies	50	Lockheed
3	Mobil	27	Boeing	51	Georgia-Pacific
4	Ford Motor	28	Dow Chemical	52	Monsanto
5	IBM	29	Allied	53	W.R. Grace
6	Texaco	30	Eastman Kodak	54	Signal Companies
7	E.I. du Pont	31	Unocal	55	Anheuser-Busch
8	Standard Oil (Ind.)	32	Goodyear	56	Nabisco Brands
9	Standard Oil of Cal.	33	Dart & Kraft	57	Johnson & Johnson
10	General Electric	34	Westinghouse Elec.	58	Coastal
11	Gulf Oil	35	Philip Morris	59	Raytheon
12	Atlantic Richfield	36	Beatrice Foods	60	Honeywell
13	Shell Oil	37	Union Carbide	61	Charter
14	Occidental Petroleum	38	Xerox	62	General Mills
15	U.S. Steel	39	Amerada Hess	63	TRW
16	Phillips Petroleum	40	Union Pacific	64	Caterpillar Tractor
17	Sun	41	General Foods	65	Aluminum Co. of Amer.
18	United Technologies	42	McDonnell Douglas	66	Sperry
19	Tenneco	43	Rockwell Int.	67	Gulf & Western Ind.
20	ITT	44	PepsiCo	68	Continental Group
21	Chrysler	45	Ashland Oil	69	Bethlehem Steel
22	Procter & Gamble	46	General Dynamics	70	Weyerhaeuser
23	R.J. Reynolds Ind.	47	3M	71	Ralston Purina
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THE PHASER II SD

I had no trouble printing drawings made in either Adobe Illustrator 3.2 or Aldus FreeHand 3.1. Graduated color fills were smooth, without a trace of dithering. Both text and fine lines were crisp and clean in any direction. The Phaser II SD's firmware uses Tektronix's Photofine image-processing software to perform edge enhancement. These Photofine algorithms do look-ahead searches in the printer's image buffer. As the print head approaches the edge boundary, Photofine adjusts the heater temperatures to sharpen the transition. I made a mock-up of a BYTE cover in Aldus PageMaker 4.2 that merged two contrasting output types: a scanned image and colored text. Photofine handled this output capably. The image looked vibrant, and yet the text still looked sharp.

Color with a Difference

So who needs such a printer? Anyone who manipulates scanned images for output to film could use the Phaser II SD to preview the results. An artist requiring fast photographic-quality output will be satisfied. Someone making overheads for a business presentation can now integrate images—say, the picture of a factory behind a sales chart—on his or her transparencies. A professional artist using object-based drawing packages with lots of color blends or gradations should check out this printer as well: My color-packed PostScript diagrams have never looked better.

Since the Phaser II SD is a continuous-tone device, you can't use it to check images for possible moiré effects. Certain color proofing can be done with a lower-priced thermal-wax printer. Also, accurate color matching is problematic unless you invest in expensive color-calibration equipment. Tektronix's TekColor software performs some color adjustments, but it's not adequate for jobs requiring serious color accuracy from monitor to printer.

If you want to buy this printer to print scanned images—and who wouldn't, with its superb output—plan to include extra RAM and the Ethernet interface for better throughput. A Phaser II SD with Ethernet and 12 MB of additional RAM (for a total of 28 MB) costs $12,475. This is still less than high-end dye-sublimation printers, and the cost per page is one of the lowest. One look at the Phaser II SD's output tells you the printer is worth it. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an associate Apple developer. You can reach him on BIX as "tom_thompson," on AppleLink as "T.THOMPSON," or on the Internet at tomt@bytepb.byte.com.

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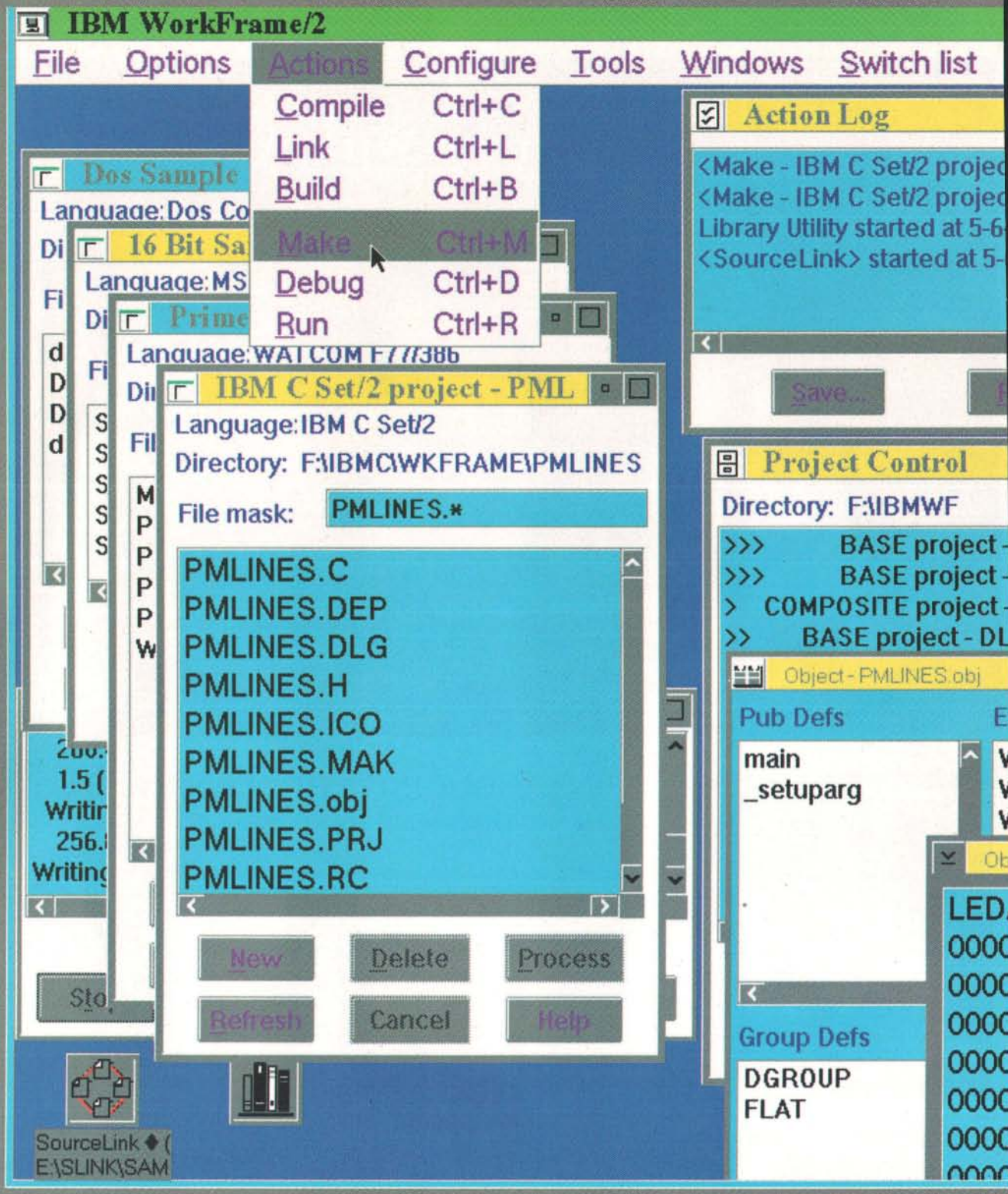

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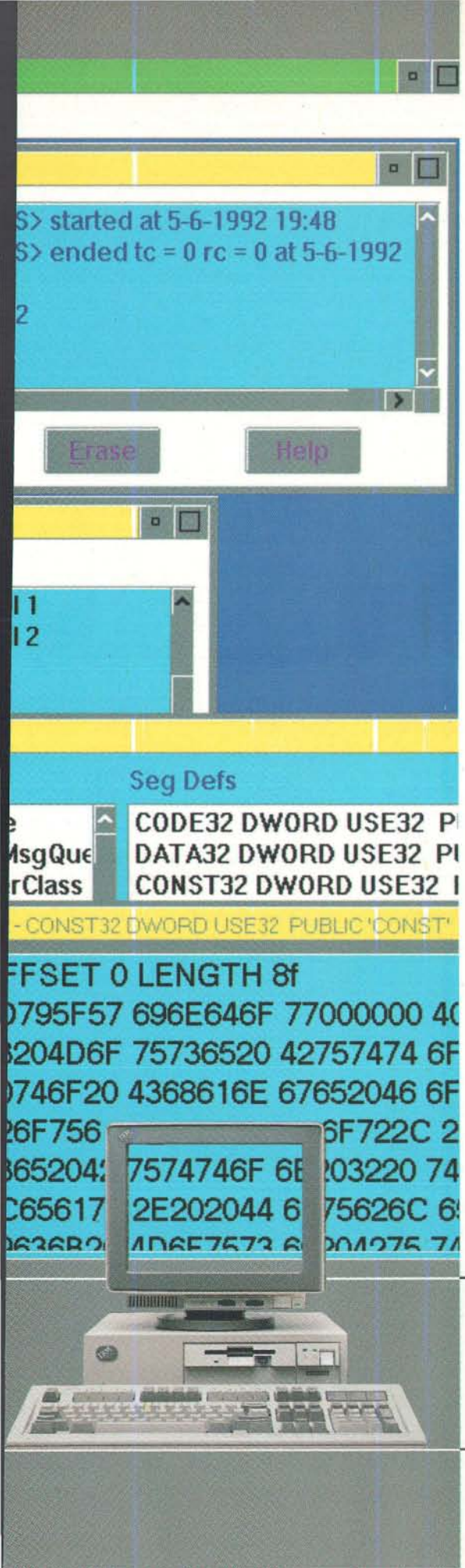

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SOFTWARE

Stepping Up to XVT 3.0

RAYMOND GA CÔTÉ

Last July, BYTE rated XVT 2.12 as the best all-around library for porting custom graphics applications to a variety of platforms (see "Code on the Move," July BYTE). The best way to summarize the newest release of XVT is to say it's still the best and getting better. It still supports the widest range of platforms: Macintosh, Microsoft Windows, Presentation Manager (for OS/2 1.3 and 2.0), Motif, and Open Look. Character-mode versions are available for DOS, various flavors of Unix, and VMS. XVT Software promises Windows NT support by year's end.

I looked at the XVT 3.0 library, XVT-Design 1.1, and XVT++ for the Mac and Microsoft Windows 3.0 and 3.1. The most significant change to the library is its use of operating-system improvements. On the Mac, for example, XVT applications are now aware of the standard suite of Apple events. Within Windows, XVT applications use common file and print dialogs.

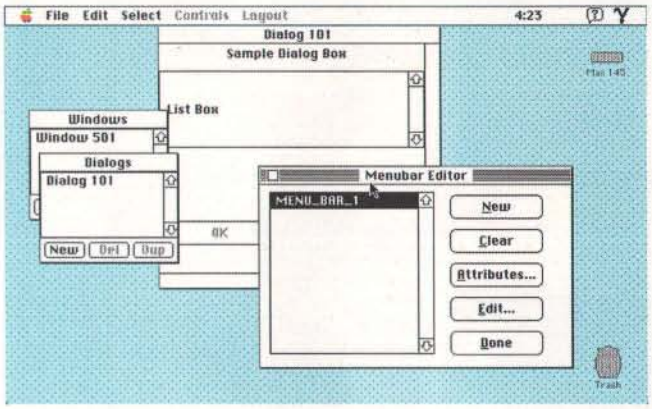
In previous releases, all window definitions were stored in a fixed resource file, and window parameters could not be changed dynamically. Version 3.0 lets you make dynamic window alterations in a portable manner. Creating international applications is much easier, since all system messages are now available as external string resources. Previously, many messages were compiled directly into the library source code.

One feature that XVT still lacks is full file-system support. For example, you can change directories or create and erase files, but you can't create a directory.

Two Tools

Not reviewed in July were two optional XVT tools: XVT++ and XVT-Design. XVT++ provides a thin interface layer between the XVT libraries and your C++ compiler. This layer is so thin that the majority of function calls are not changed at all; they're merely provided in a header that declares them as C functions.

XVT++ defines a set of base classes. BaseXVT is an abstract base class from which all other classes are derived. Control, for creating and manipulating controls, and BaseWin, for windows and dialogs, derive directly from BaseXVT. The last four classes derive from BaseWin and support dialog boxes and standard windows. All popular C++ compilers are supported under DOS and Windows. On the Mac, unfortunately, XVT++ supports only MPW C++. Under Unix, XVT++ supports any compiler compatible with Unix Systems Laboratories' Cfront interpreter.



XVT-Design, a new option available with XVT 3.0, is a screen prototyper that generates code and resources that are portable between platforms.

XVT-Design (see the screen) is an interactive graphical design tool and applications generator. It provides all the prototyping tools you expect, without a lot of frills. You can design windows, modal and modeless dialog boxes, and menus.

Once the prototype is complete, XVT-Design generates both the C code for a sample application and a portable file containing the Universal Resource Language definition of your resources. URL is not a new feature, but it's one of the most powerful features of the entire XVT environment. It defines a portable format for resources like windows and dialogs. XVT provides a URL compiler (CURL) on each platform. CURL translates resource information, not into binary format, but into the standard resource format for that platform.

XVT is a fairly expensive solution and still has some minor deficiencies. However, with standard library improvements and especially with XVT++ and XVT-Design, XVT Software has succeeded in improving a great environment for developing portable applications. ■

Raymond GA Côté is a testing editor for the BYTE Lab. He has worked in industry designing interpretive languages and user interfaces. You can reach him on BIX as "rgacote" and on the Internet at rgacote @bytepb.byte.com.

BYTE ACTION SUMMARY

- **WHAT XVT 3.0 IS**
  The latest version of XVT's multiplatform C interface library.
- **LIKES**
  Strings available as resources; dynamic window modification; XVT++ and XVT-Design. Library is royalty-free.
- **DISLIKES**
  Expensive, and still provides only a partial set of file-support functions.
- **RECOMMENDATION**
  XVT 3.0 is an improved version of the best portable interface library, and a good solution to moving applications between environments.
- **PRICE**
  XVT 3.0, $1450 to $4400
  XVT++, $200
  XVT-Design, $1200 to $2900
  (Prices vary according to platform)
- **FOR MORE INFORMATION**
  XVT Software, Inc.
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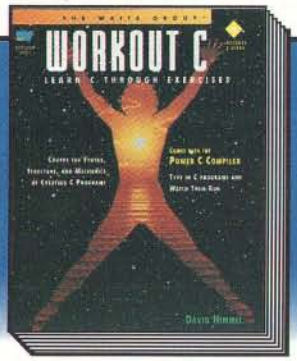

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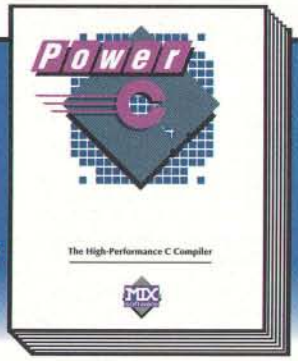

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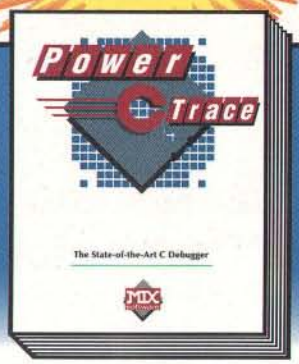

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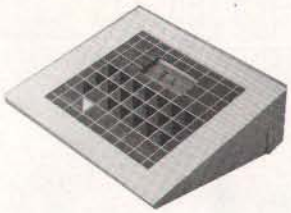

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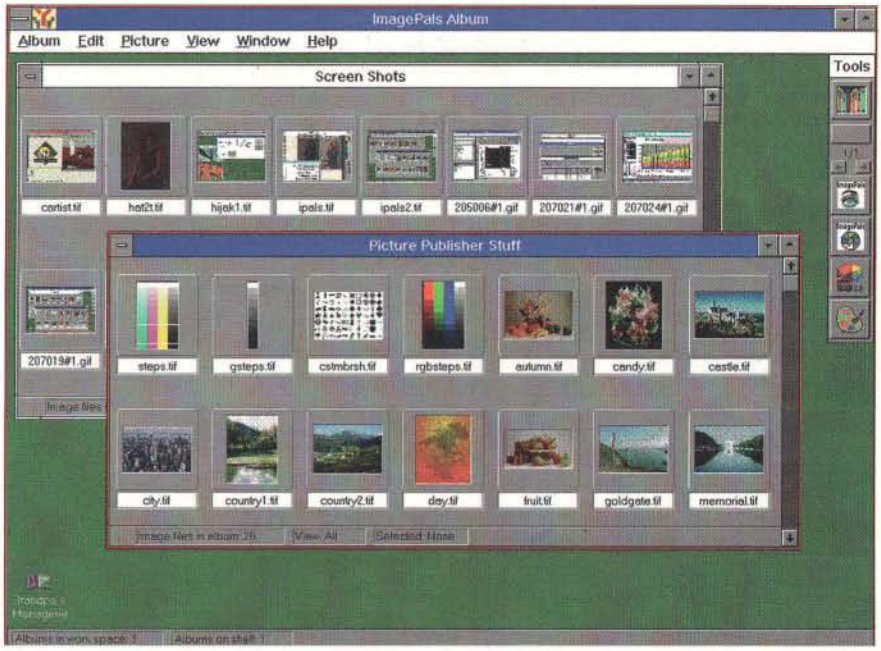
SOFTWARE

The Windows File Shuffle

STANFORD DIEHL AND DANA HUDES

Windows file-conversion software solves some basic problems we all encounter when working with graphical images. These compact tools accept a wide range of graphics files, allowing you to display them, print them, or convert them to the file format you need.

Although limited in scope, the programs are easy to use and deliver a convenient method for performing some routine image management chores. If you work with image files under Windows, one of these utilities will be a handy tool to have around. You'll probably end up wondering how you ever got along without it.



With Image Pals, you can collect thumbnail versions of your selected images, along with an optional title and description, into a simple image database.

The Field

We looked at three of these products: HiJaak for Windows 1.0 from Inset Systems, Conversion Artist 1.1 from North Coast Software, and Image Pals 1.0 from U-Lead Systems. All three perform basic file conversion among the most popular graphical file formats. They also support Windows screen captures, color reduction (e.g., converting a 24-bit color image to 8 bits), and a convenient way to print your images. These basic functions and a few extra perks add up to a general-purpose utility that anyone who works with a lot of images will come to depend on.

The accompanying table lists the file formats supported by the programs. While some other formats are supported by HiJaak for Windows and Conversion Artist, the list covers the most popular formats you are likely to run into. If you work with a specific format not appearing in the table, you should call the vendors for a complete list of supported formats.

The benchmark graphs show how the programs perform on routine tasks such as loading files and converting files to various formats. For the first test, each program pulled in a large (2.4-MB) 24-bit TIFF file from a Bernoulli Transportable cartridge. The second test gauges conversion speeds: a 24-bit Windows bit map was converted to the TIFF format; a TIFF file was then converted to a 24-bit PCX file; and, finally, a Targa file was converted to TIFF. To test the speed of color reduction, each program took a true-color (16 million colors) TIFF image and reduced it to 256 colors. Each program offers user-selectable algorithms for color reduction (e.g., dithering and diffusion); thus, for each package, we selected the algorithm that resulted in the highest-quality image possible. The last test shows how long it takes to scale an 8-bit gray-scale image and send it to the printer.

Artist with a Broad Brush

Of the three programs reviewed here, Conversion Artist ($149) is the strongest entry for nuts-and-bolts file conversion. File support is extensive, and the interface takes a no-nonsense approach to the task at hand. When you open a file, a dialog box displays vital information on the file—format, size, color depth, compression status—as it is loaded. Once the image loads, file information is listed at the bottom of the screen.

Image conversions are triggered from the Save As option of the File menu. In addition to the rich complement of supported formats, Conversion Artist offers you a choice of color depth for almost every file it supports. You can quickly convert a 24-bit TIFF image to a 256-color bit map, performing conversion and color reduction in one easy step.

Screen capture options let you decide which portion of the screen to capture: the active application, the entire screen, any open window, or a rectangle you set up with a click and drag of the mouse.

Conversion Artist is quick and convenient. The basic program offers a handy, uncluttered utility for those needing only to convert files and capture screens. But if you need more functionality, the program supports optional "plug-in" modules. By simply copying DLLs into Conversion Artist's working directory, you can upgrade the program to include image-manipulation features such as rotation and cropping (the image-preparation module sells for $69).

Other modules include support for color separations ($149), JPEG compression ($99), and the Dycam digital camera ($5). You can add new modules as they become available while paying only for what you need. Let's hope that philosophy also guarantees that the basic version of Conversion Artist is always available for those who need a simple, fairly inexpensive Windows file-conversion utility that gets the job done.

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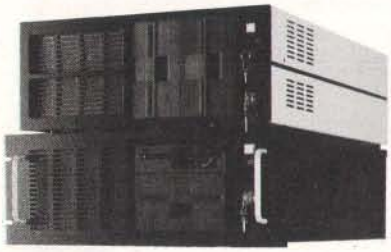

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A DOS Mainstay Comes to Windows

HiJaak for Windows ($249) is a GUI version of the DOS graphics-file-conversion utility that has been around for a number of years. At first glance, HiJaak for Windows looks like an impressive offering. The program supports a broad range of file formats, including the most extensive support of vector formats among the programs we reviewed. It also claims some powerful image-processing features:

FILE FORMATS SUPPORTED

While some other formats are supported by HiJaak for Windows and Conversion Artist, this list covers the most popular formats you are likely to encounter in the Windows environment. (● = yes; ○ = no.)

	HiJaak for Windows	Conversion Artist	Image Pals
Price	$249	$149	$249
File formats (raster)			
TIFF 5.0	●	●	●
Windows BMP	●	●	●
Targa (TGA)	●	●	●
PCX	●	●	●
GIF	●	●	●
JPEG	○	●	●[1]
WPG (raster)	●[2]	●[2]	○
IFF (including HAM)	●	●[3]	○
MacPaint Mac	●	○	○
Macintosh PICT2		○	○
CCITT Group 3 and 4 fax	●	●	○
HP PCL	●[3]	○	○
Vector formats			
HPGL	Read only	○	○
AutoCAD DXF	Read only	○	○
EPS (PostScript)	Write only	○	●[4]
DRW (Micrografx)	●[3]	○	○
WMF (Windows metafile, vector)	●	●	○
WPG (vector)	●	○	○

[1] Offers subsample control for the RGB-to-YUV color-space conversion.
[2] 24-bit WPG not supported.
[3] Support claimed, but testing showed it did not work.
[4] Only EPS files it creates.

BYTE ACTION SUMMARY

WHAT GRAPHICS FILE–CONVERSION PROGRAMS DO
These utilities convert files to and from a wide range of file formats. They also capture screens and provide tools to display, enhance, and print graphical images.

LIKES
The tools are easy to use and solve the complex problem of converting among divergent file formats under Windows.

DISLIKES
HiJaak for Windows is slow and somewhat unstable. Image Pals supports a limited set of file formats.

RECOMMENDATIONS
Conversion Artist supports a wide variety of file formats at a reasonable price. It's quick, easy to use, and convenient.

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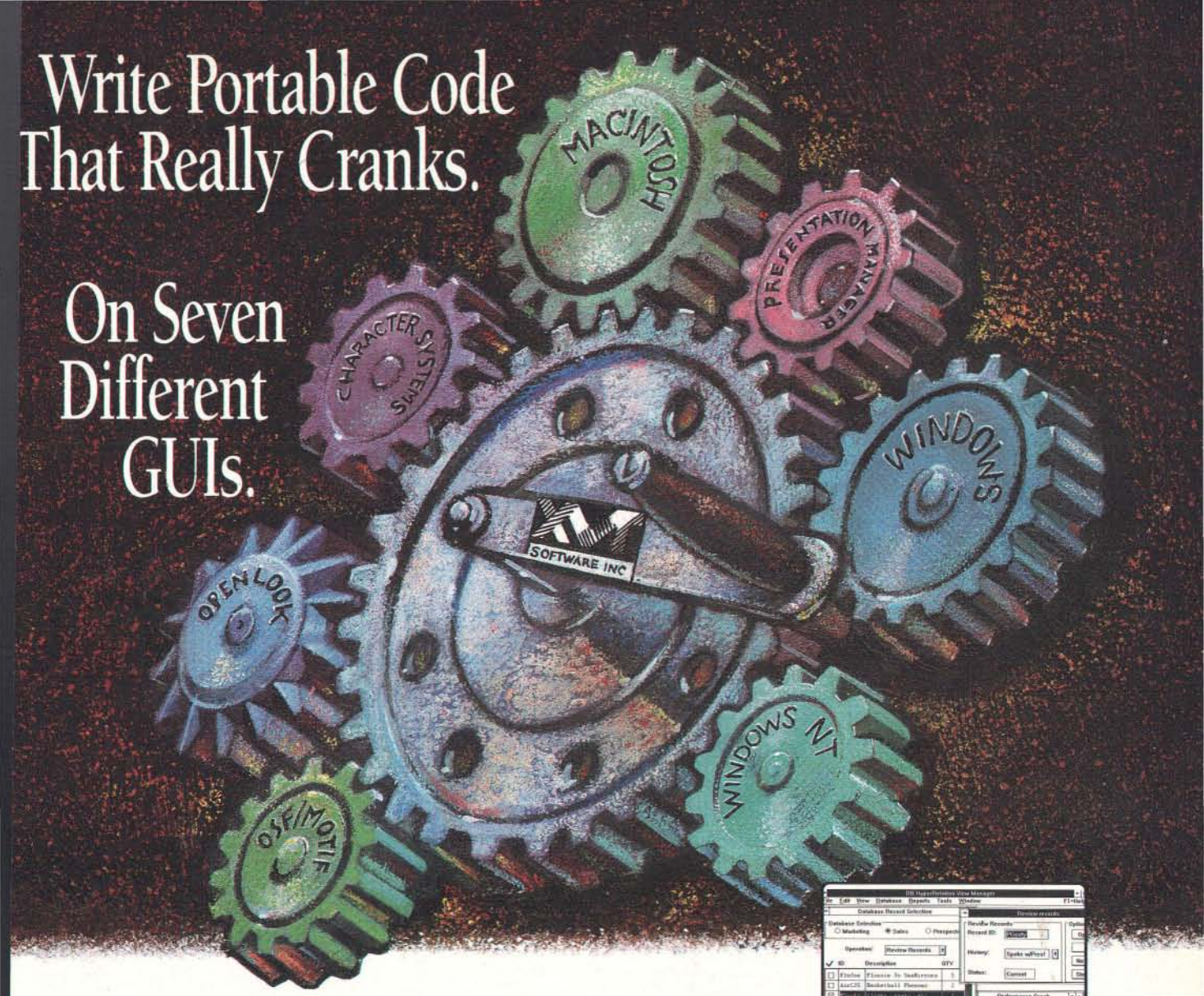

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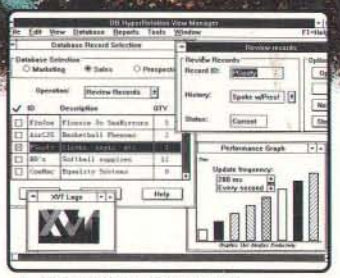
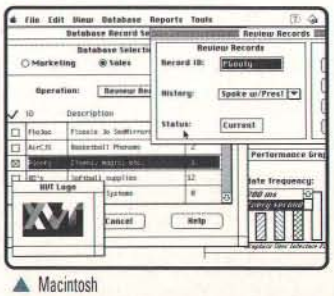


▲ Microsoft Windows & Windows NT



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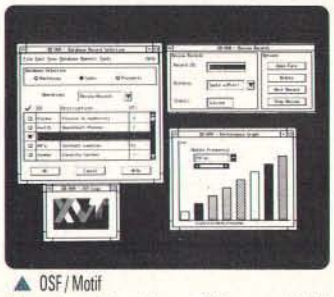

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Shown above are four of the seven GUIs supported by XVT.

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a range of color-reduction methods, cropping and resizing, and controls for adjusting brightness, contrast, and gamma.

The program has some unique features. For example, you can customize your file conversions for specific applications. Let's say you have an image file that displays particularly well in Ami Pro. HiJaak for Windows can use the optimized image file as a model, using the same parameters to convert other images for use in your Ami Pro documents.

Screen capture is also impressive. You can capture an entire screen, an active window, or an object such as an icon or a pull-down menu. If you need more flexibility, HiJaak lets you draw a rectangle on the screen for customized captures.

There's also some nice convenience features. For instance, you can convert files from the Save As menu option, or you can go directly to the Convert menu and perform conversions without having to load the files into memory. A command-line option even allows you to use wild-card designators to batch up conversion jobs.

For all that's right with HiJaak for Windows, the program is hampered by some serious flaws. First of all, the program is s-l-o-w. Our benchmarks tell only part of the story. With a 24-bit TIFF image loaded, it sometimes took up to 30 seconds just to call up a dialog box. To get a feel for each of the reviewed programs' operation, we called up a large TIFF image and did some work with it: converting it, changing its color depth, cropping it, and the like. With the other two programs, we faced some minor delays in loading files and making changes, but the software was generally responsive. Not so with HiJaak for Windows. Its performance was downright irritating, taking two to three times longer than the other programs to do almost every operation.

On top of that, the program proved unstable. For each of the reviewed programs, we loaded up five different files of various formats to see how they performed with multiple files on the desktop. HiJaak for Windows was the only program that ran out of memory during the test. That's not so bad, but it handled the problem with a total lack of grace, tossing out a warning and then dropping back to the program manager.

To test the program's ability to read Hewlett-Packard Printer Control Language (LaserJet command codes), we converted a color image to gray scale in Aldus PhotoStyler and used the Windows HP LaserJet printer driver to print the file to disk. HiJaak loaded the resulting file as solid black. When printing, we took the printer off-line and caused all sorts of havoc,

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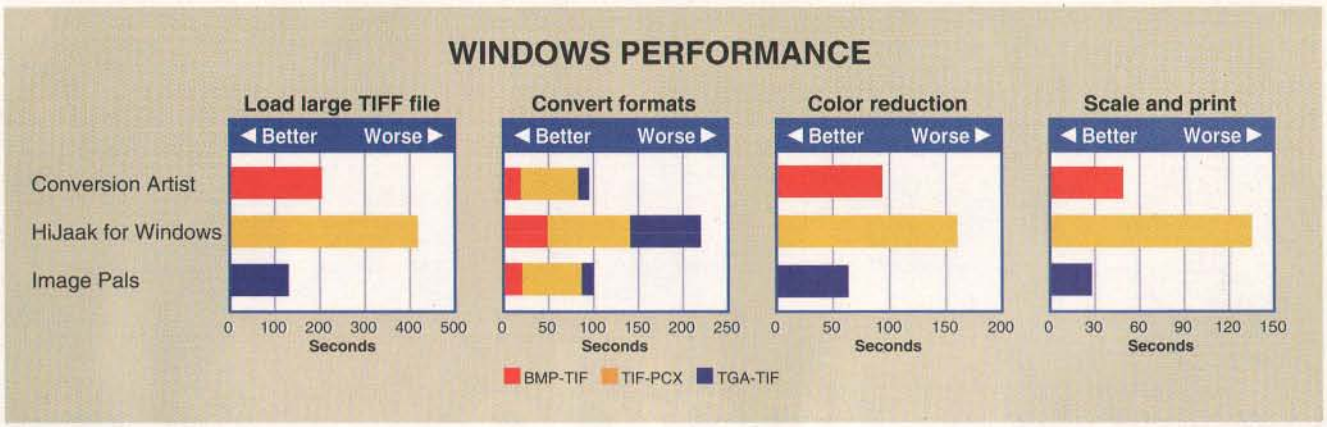

Benchmark tests show the kind of performance you can expect from these programs when running routine operations. First, we loaded a large (2.4-MB) 24-bit TIFF file. The second test gauges conversion speeds. To test the speed of color reduction, each program took a true-color (16 million colors) TIFF image and reduced it to 256 colors. For the last test, we scaled an image and sent it to the printer. Overall, Image Pals was the top performer.

ending in a "General Protection Fault." Clicking the Cancel button at an inopportune moment during file loading causes the same result, as does loading a Micrografx Windows Draw (DRW) file.

HiJaak for Windows has a broad set of features, but performance and reliability are too suspect to warrant a recommendation.

An Old Pal Comes Back Around

Image Pals ($249) comes from U-Lead, the company that originally produced PhotoStyler, one of the first image-editing programs for Windows 3.0. Image Pals shares some of PhotoStyler's low-end functionality, but image-editing features are not the product's strong suit. Image Pals provides a set of utilities for doing the quick-and-dirty jobs we all face when working with graphical images. Some useful modules support image enhancement and adjustment, screen capture, file conversion, and image cataloging.

Image Pals does not enjoy the same breadth of file-format support as Conversion Artist; instead, U-Lead has settled on a strategic set of popular formats often encountered under the Windows interface. On the other hand, Image Pals has the strongest set of image-manipulation features among the products tested. You can flip an image or rotate it to any degree specified. The dimensions of an image can be changed along with the image resolution. There's a whole range of image adjustments, and you can subtly blur or sharpen an image to suit your needs. Some special-effects filters (e.g., mosaic and emboss) are also included.

Scanner support is strong. A host of input devices is supported through the TWAIN driver, and stitching is offered from within Image Pals, allowing you to piece together an image from a number of separate scans. The Capture module lets you capture a full Windows screen, any open window, or a rectangle you specify by clicking and dragging.

The Album module helps set this program apart from the others. You collect thumbnail versions of your selected images, along with an optional title and description, into an "album" (see the screen on page 225). Multiple albums can be open as individual document windows, and each can be searched on various criteria, including the label and the description. Drag-and-drop is supported for quickly loading your images into other Windows programs.

Image Pals offers a set of handy utilities for managing and manipulating graphical images. It falls short of providing some high-end features such as color separations, but it fulfills some of the simple needs most of us have. It was also very snappy; overall, it performed the best on our benchmark tests. This is a handy program to turn to when a full-fledged image-editing application is overkill.

A Click Away

Image Pals has some nice perks not found in Conversion Artist. The Album module could be an effective way to catalog your image files, and it should work nicely with the new Kodak Photo CD. As long as you can live with the limited number of file formats supported by Image Pals, you should go with it. But for those of us trying to cope in the diverse world of multiple file formats, Conversion Artist is a solid solution. It doesn't have some of the image-editing features of Image Pals, but it covers a broader range of file formats.

Conversion Artist is the best choice for handling a large assortment of file flavors. It's quick, easy, and convenient. Next time your graphical application balks at an incompatible file format, you'll appreciate having Conversion Artist a click away. ■

Stanford Diehl is a technical editor for the BYTE Lab. You can reach him on BIX as "sdiehl." Dana Hudes is a freelance software engineer, writer, and photographer. You can reach him as "dhudes" on BIX, where he moderates the photo conference, or at dhudes@mcimail.com on the Internet.

COMPANY INFORMATION

Inset Systems, Inc.
(HiJaak for Windows 1.0)
71 Commerce Dr.
Brookfield, CT 06804
(203) 740-2400
fax: (203) 775-5634
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(Conversion Artist 1.1)
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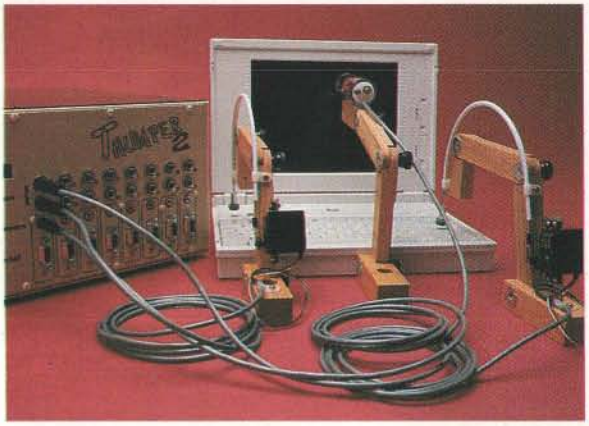
A Real-World Notebook Battery Test

HOWARD EGLOWSTEIN

BYTE's laptop battery tests used to be simple—turn on the laptop, wait until the battery dies, and record the elapsed time. Although BYTE was among the first to begin a formal battery-testing program as part of its portable-system review process, we realized that the battery test just didn't reflect the way people actually used the systems. For example, while sitting in an airplane, people may type for a bit on a machine, turn it off when they're served that sumptuous airline food, and then turn the power back on afterward.

Thumper II is platform-independent: If a portable can be programmed and it has a serial port, it can be thumped



Along Came Thumper II

The prototype for Thumper II, BYTE's automated battery tester, was finished in early 1991. Self-contained closed-loop servo motors, attached to multijointed flexible wooden arms, press on the laptop's keys via flexible cables. The control circuitry provided the pulse-width modulation the motors required and support for an optical-sensor head to read screen status. The Thumper II prototype could handle four motors at the same time and was designed to test two machines simultaneously. (Thumper II first appeared in the text box "Testing Battery Life" on page 252 of the December 1991 BYTE.)

For the production version, I replaced the prototype's dedicated pulse hardware with a microprocessor and increased Thumper's capacity from two machines to eight. The controller cabinet is a rack-mountable box with 33 front-panel connectors and an LCD (see the photo). Thumper II's heart and soul is an 8-MHz 6809 processor with nine serial ports and interface circuitry to control 16 servo motors and read from eight optical sensors. The muscle to press the keys comes from 16 redesigned arms.

During testing, one arm handles the notebook's Enter key, and one or two more arms use the standby/power function to reactivate the notebook if it shuts itself off. The system determines the notebook status by watching the screen with one of the optical sensors. Power for the arm's mechanical finger comes from a closed-loop servo motor linked through a flexible cable.

The notebook being tested runs a control program that simulates the load a word processor puts on a computer during normal use. Thumper II is fully platform-independent; if you can program a portable and it has a serial port, it can be thumped.

Getting There

Thumper's new controller is a full-blown microcomputer, and putting it together required some special tools. Once I had designed the 6809 system board, I called Huntsville Microsystems, Inc. (Huntsville, AL, (205) 881-6005), and borrowed a 6809 emulator. Its system uses a PC for interface and control and connects to the target system with a ribbon cable. One critical feature of the HMI emulator is the 6809's MRDY line. MRDY is a processor input that allows a slow peripheral to extend the system clock—similar to the way IBM PCs use wait states. I needed this input to handle Thumper's slow LCD. The HMI emulator also provides multiple hardware breakpoints, symbolic debugging, and a user interface.

Universal Cross Assemblers (Saint John, New Brunswick, Canada, fax (506) 847-0681) makes a great table-driven cross assembler (Cross-32) that supports oodles of different processors. The processor support is a series of ASCII files with the processor instruction sets. If they don't support the processor you need, it's an easy matter to write your own table.

Thumper's controller cabinet is a modified version of the DataPad cabinet from Interface Systems (Williamsville, NY, (716) 634-0492). Building data acquisition hardware (like Thumper) can be tricky, so I brought Interface Systems onto the design team. I contracted the system board layout and mechanical development to the company's engineers.

I uncovered only one serious problem during Thumper's shakeout testing. The original design used a self-clocking circuit to mimic the function of the dedicated pulse generators I used in the Thumper II prototype. The idea was to have the processor load up a memory array with the pulse-width information and then let dedicated hardware take over. It was obvious there was a timing glitch in the system, but I didn't have a clue where to look first. I turned to BYTE's HP 16550 Logic Analyzer. I connected 60 of its logic probes to key parts of the system board and told the analyzer to look for problems. Five minutes later, the HP 16550 stopped and displayed the culprit.

A Design for the Future

Thumper II is about as close as anyone has been able to get to a real-world battery-life test. It allows for notebooks of any size and shape and for efficient use of standby mode on 386SL processors. It does all this with a single control computer for eight notebooks.

As pen-based computers become available, I'll design new battery-life tests for these machines. I've got an actuator design on the drawing board with three motors for x, y, and z control, and Thumper's firmware already supports it. You won't see effective pen-based testing from any solenoid-based designs. We also plan to use Thumper's optical sensors for further automating Windows and other GUI-applications testing in the Lab. ■

Howard Eglowstein is a BYTE Lab testing editor who has developed microprocessor systems and firmware since the 1970s. You can contact him on BIX as "heglowstein."

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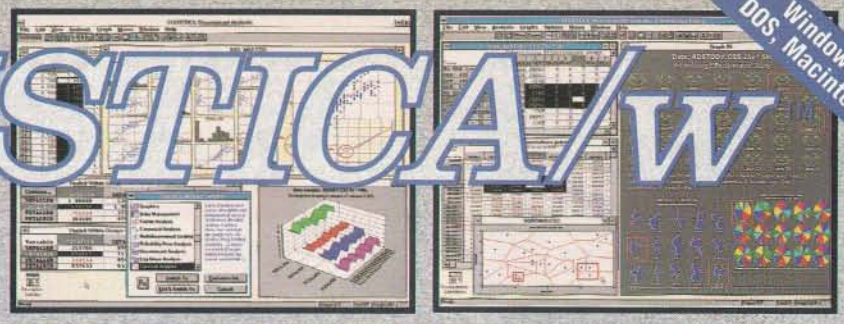

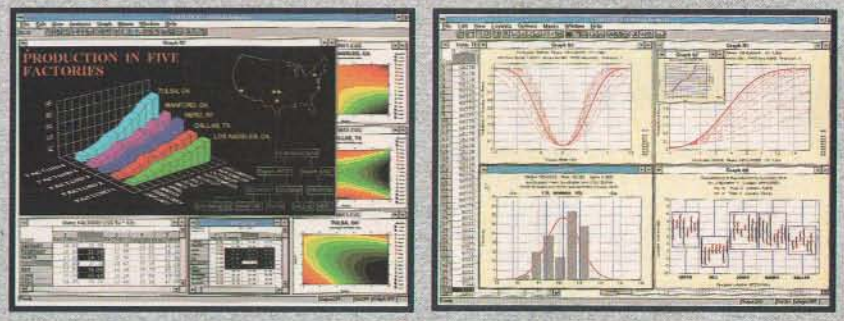

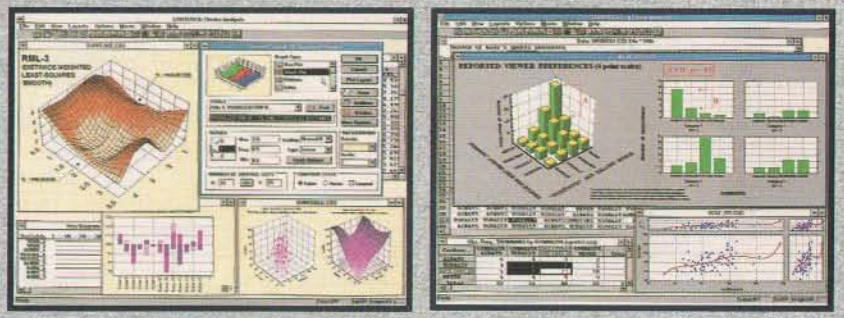

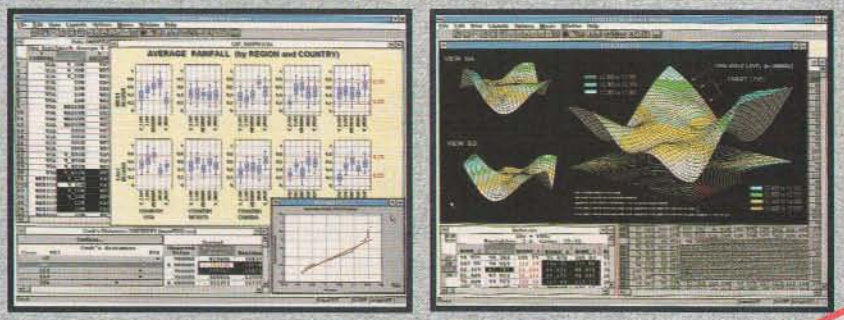

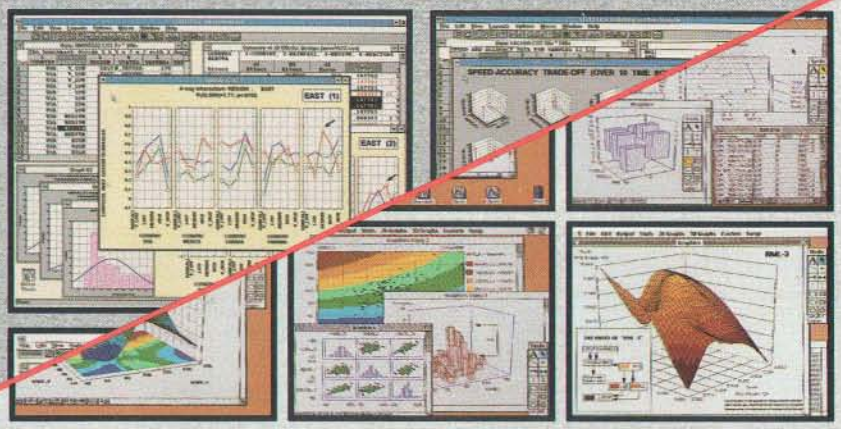

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BOOK
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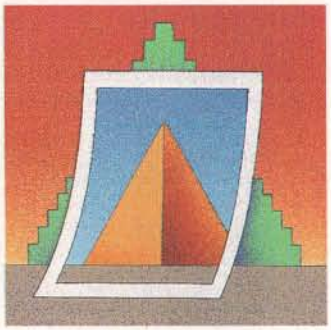
HUGH KENNER



PHOTOGRAPHIC LIES

The Reconfigured Eye: Visual Truth in the Post-Photographic Era
William J. Mitchell

Assembly Language Step by Step
Jeff Duntemann

The camera, they used to tell us, could not lie: something new, because the painter certainly could. Its optical laws assured accurate scale and placing, compliant with the geometry of space. But man's heart differs from the Leica's in being a dark forest indeed, and when Leon Battista Alberti in 1436 outlined the algorithm for doing true perspective by hand, clever painters were quick to spot merely a recipe for faking what never was.

Getting rid of the human agent: about 1840 that was like the newfangled scientific method, with its sentences devoid of people—"The rabbit was sacrificed by a blow to the cranium." Once you let humans in, you're mired in fudging, messiness. Sure enough, humans soon learned to fudge even photos; a print, for instance, might draw on more than one negative. Still, page-turners kept the faith. For "a photograph is fossilized light," William J. Mitchell reminds us in *The Reconfigured Eye: Visual Truth in the Post-Photographic Era*. If we believe it's fossilized light we'll trust it, and even voyeurs of the *National Enquirer* tend to trust whatever photos that strange rag may offer. For the camera can't lie, can it?

Well, it can be made to lie, and in a good many ways. But Mitchell's book turns on the fact that nowadays you can't be sure if you're looking at camera-work or not. It may have started as camera-work. Still, you may be looking at a digitized image, something as easy to fake as to offer straight. There it differs from the photo, troublesome to fake and fakeable only in ways that, once suspected, aren't hard to detect.

The digitized image exists as a grid of numbers, each naming the state (i.e., hue, brightness) of 1 pixel. Those have, say, 128 levels, or 256 or 512 (no fractions), whereas the photo, anywhere we look, may differ only fractionally from the way it looked a fraction of an inch away.

On the up side, the digitized image is stable in a way photos are not. Sequential photocopies of a photo decline toward mush. But a digital copy of a copy of a copy is exactly like any other copy; that leaves questions about "the original" nearly meaningless.

On the downside, the digitized image is infinitely malleable. Footsy with those numbers can make anything possible.

Here we're on tricky ground indeed. Some things you can do with a digitized color picture include sharpening contours, or blurring them; shifting the color balance in any direction (toward green, toward orange); slicing out relative blankness; inserting forms that were never there till you dreamt of them; deleting forms that were only there while you stared at them; altering a nose to be a Pinocchio-nose; and culling a rose to do for one pink, pert pose.

Most of us have inherited a faith in the photograph. And most readers of BYTE use computers. The nagging theme of Mitchell's book is that those two statements won't quite coexist. For (thanks to the computer) is there anything left you can be sure is *simply* a photograph?

Short Subject

A while back I reviewed Jeff Duntemann's *Assembly Language from Square One*, an exemplary book that in the way of things exemplary became, almost overnight, unavailable (something to do with publishers buying up publishers). Wiley has now reissued it as *Assembly Language Step by Step*. It's been cleaned up and tightened throughout, and it sports two additional chapters: on string functions, and on the "brave new world" of 286, 386, and 486 instructions. There's still no better introduction to assembly language. ■

The Reconfigured Eye: Visual Truth in the Post-Photographic Era, William J. Mitchell, MIT Press, $39.95, ISBN 0-262-13286-9.
Assembly Language Step by Step, Jeff Duntemann, Wiley, $32.95, ISBN 0-471-57814-2.

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. His recent books include Mazes *and* Historical Fictions. *You can contact him on BIX as "hkenner."*

THE COMPLETE TCP/IP

TCP/IP Network Administration, Craig Hunt, O'Reilly & Associates, $29.95, ISBN 0-937175-82-X.

Craig Hunt's *TCP/IP Network Administration* is the most complete TCP/IP book I've seen. Despite its technical depth, it doesn't assume too much knowledge. You'll have to know Unix (the book uses SunOS for most examples, but it also refers to SCO Unix fairly frequently), but beyond that, the author doesn't even assume you currently have a network.

TCP/IP Network Administration reads like the condensation and analysis of every Unix network manual ever written. There's plenty of reference material; every Unix network administration command introduced, for example, has its own reference manual–style entry. And unlike Unix documentation, which often stops at the basics, this book details everything from applying for connection to the Internet to the format of various TCP/IP packet headers. Of particular note is the section that makes sense out of the convoluted configuration files used by the BSD E-mail daemon `sendmail`. This book makes it clear through its use of copious explanations and clear figures.

Whether you're putting a network together, trying to figure out why an existing one doesn't work, or wanting to understand the one you've got a little better, *TCP/IP Network Administration* is the definitive volume on the subject.

—Tom Yager

ILLUSTRATION: MARK FISHER © 1992

THE ARTIST'S NEW TOOLS

Design Essentials, Luanne Seymour Cohen, Russell Brown, Lisa Jeans, and Tanya Wendling, Prentice-Hall Computer Publishing, $39.95, ISBN 0-672-48538-9.

I've spent many hours of work on computer-generated drawings, only to discard them and start over. Why? Because along the way I discovered an easier and better way to accomplish the same result. At times it's quite tricky rethinking artwork into Bézier curves, PostScript curves, and clipping paths.

Design Essentials gathers such electronic tricks and techniques into one volume that covers drawing, painting, and printing. The drawing section shows you how to create offset outlines (for a drop-shadow effect), draw a five-pointed star, produce 3-D charts, make smooth blends, and generate color gradations within letters. The painting section teaches you how to add drop shadows or an embossing effect to objects; create glowing, shadowed, or recessed text; generate custom textures; and add a stippled appearance to images. The printing section offers a brief explanation of color trapping and overprinting. It also tells you how to halftone an image and create stereoscopic images. Numerous photos and diagrams show explicitly how to achieve a certain effect or result.

If you send drawings to a typesetter for output, the section on creating smooth color blends includes formulas that explain how to calculate the minimum number of gradation steps required to create a smooth blend on the typesetter. This information prevents you from creating artwork that prints on a laser printer but results in costly typesetter crashes. While these tips are oriented around Adobe's Illustrator and Photoshop applications, you can easily apply the techniques in other drawing and painting applications. Even if you're a design expert, you'll find timesaving shortcuts in this book.

—Tom Thompson

CD-ROM SMORGASBORD

Nautilus, $137.40 per year (13 issues) from Metatec Discovery Systems, 7001 Discovery Blvd., Dublin, OH 43017, (800) 637-3472 or (614) 766-3165; fax (614) 761-4110.

Nautilus offers a potpourri of information in a monthly format that includes news, shareware programs, demonstration software, images, and sounds for Windows users. The content, regrettably, is a bit weak.

In the three editions I saw, the news items consisted of rehashed press releases with little analysis or objective reporting. Most of the games were bland, and the educational essays offered limited scope and depth. A listing of CDs was so full of marketing hype that I found it impossible to separate the good products from the bad. And the educational programs consisted mainly of demonstration programs.

Nautilus has potential but needs a focus. It falls into the old trap of trying to please everyone and comes up short all around.

—Stanford Diehl

GENIUS AT WORK

Genius: The Life and Science of Richard Feynman, James Gleick, Pantheon Books, $27.50, ISBN 0-679-40836-3.

Richard Feynman's best-selling as-told-to autobiography, *Surely You're Joking, Mr. Feynman*, portrays the renowned theoretical physicist as a wisecracking, safecracking prankster, an aw-shucks prodigy who just happened to have been on hand to help build the atom bomb and then, over the next few decades, steer the course of quantum physics. Through the lens of James Gleick's superb biography, a more complex and more human Feynman comes into focus. His often childlike behavior reflected a conscious commitment to retain the clean perceptual slate "that was what made every child a physicist."

Never wholly comfortable with the fashionable physics of probability, strangeness, and charm, Feynman returned again and again to first principles and worked toward an understanding of nature rooted in physical, not just mathematical, intuition. The legendary, near-mystical insights that he regularly produced more than justified Feynman's willful rejection of the techniques and dogmas of his professional peers. Gleick shows us, as Feynman himself could not, that such iconoclastic methods might as easily terrify as inspire. Some colleagues' egos and careers were permanently sabotaged by encounters with the slashing Feynman intellect.

But Gleick also shows us a private Feynman whose first wife, Arline Greenbaum, suffered a long and ultimately fatal bout of tuberculosis. Even while engrossed in the Los Alamos project—theorizing about implosion effects, organizing a roomful of calculator-wielding volunteers to form a human-powered computer, analyzing the risks of storing increasingly pure supplies of uranium 235, and all the while upholding his reputation as an irreverent practical joker—Feynman spent every weekend at an Albuquerque sanatorium with his dying lover. An anguished love letter that was written to Arline two years after her death reveals a private torment and sensitivity wholly at odds with Feynman's brash public image.

We learn too of Feynman's occasional yet fruitful excursions outside physics. His computational work at Los Alamos scratched the surface of parallel processing. Thinking about miniaturization, he offhandedly invented the field we now call nanotechnology. During a brief stint as an amateur geneticist, Feynman stumbled across a phenomenon called intragenic suppression, which, discovered independently soon after, led Francis Crick to an understanding of how the genetic code is expressed.

Finally, wracked with cancer, Feynman served on the commission investigating the space shuttle *Challenger*'s catastrophic end. His dramatic experiment with a chunk of O-ring rubber, a C clamp, and a glass of ice water caught the NASA bureaucrats flat-footed. "The public saw with their own eyes," Gleick reports Freeman Dyson to have said, "how a great scientist thinks with his hands, how nature gives a clear answer when a scientist asks her a clear question."

—Jon Udell

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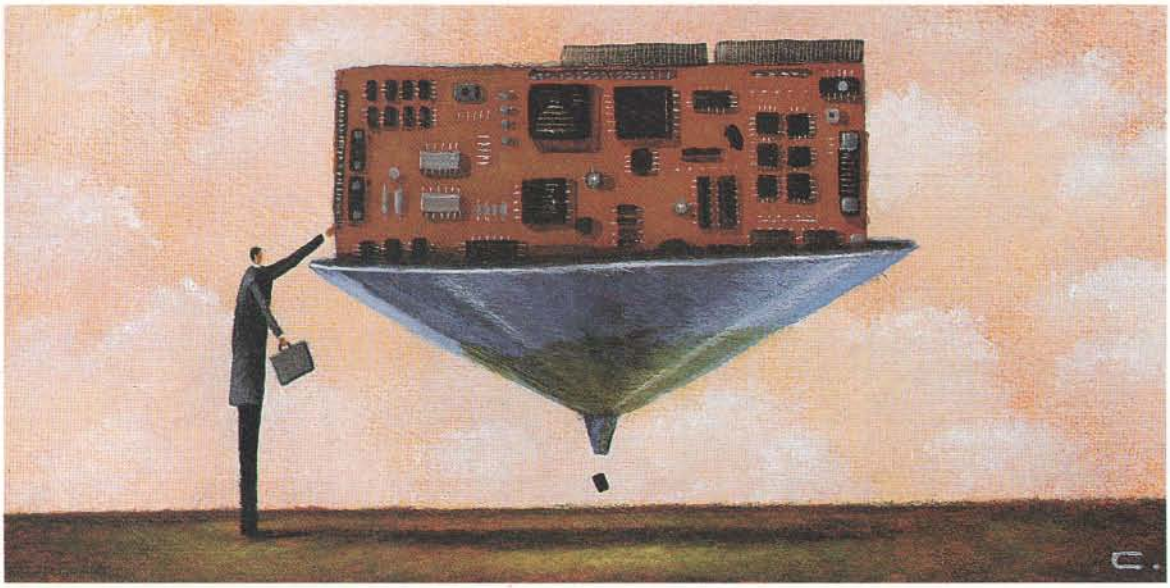
Circle 119 on Inquiry Card

ROGER C. ALFORD

THE PCMCIA REDEFINES PORTABILITY



The new PCMCIA PC card standard moves beyond memory cards to support general peripheral expansion and I/O cards

Advancing technologies have driven the development of a new generation of notebook and subnotebook systems that boast a longer battery life, faster processors, more memory, greater mass-storage capacity, and better displays. These systems pack desktop-level performance, but they have lacked the standard expansion slots common to desktop systems. The relatively new PCMCIA (Personal Computer Memory Card International Association) standard is changing that, opening the door to placing add-ins such as modems, network adapters—even disk drives—on a device approximately the size of a credit card.

The PCMCIA was born out of the need for a removable mass-storage alternative to the relatively large and power-hungry floppy drive for notebook and subnotebook computers. Memory cards were a viable, low-power alternative to floppy disks for such applications, so the PCMCIA developed an interface specification to standardize the electrical, mechanical, and functional interfaces for these cards. Shortly thereafter, the PCMCIA enhanced its PC card standard to look more like a memory and peripheral expansion slot.

The PCMCIA standard has been widely accepted by a long list of established computer-industry vendors, including IBM, AT&T, Intel, NCR, and Toshiba. As you read this, a deluge of new PCMCIA-compatible systems and add-in cards should be hitting the market. Modem and network-interface cards are already available, and disk drives on a card are sure to appear in 1993. The first systems to include PCMCIA slots are already here: AST's PowerExec 386SL/25 and Dell's 320SLi are two such systems introduced earlier this year.

The First Release

Release 1.0 of the PCMCIA standard, introduced in August 1990, supported all standard memory types except for DRAM. The list included ROM, OTPROM (one-time programmable ROM), UV-EPROM (ultraviolet EPROM), EEPROM, flash memory (a newer, more economical type of EEPROM), SRAM (static RAM), and PSRAM (pseudo-SRAM, a type of DRAM that acts like SRAM). PCMCIA has worked closely with JEIDA to introduce standards documents in Japan that correspond to those issued in the U.S.

The release 1.0 interface was adequate for supporting memory cards, but the PCMCIA went on to include many general-purpose enhancements in release 2.0 in September 1991. Enhancements included support for I/O devices, additional support for flash-memory devices, support for dual-voltage (5-volt/3-V) cards, and an XIP (execute-in-place) mechanism. The dual-voltage card support allows for the next generation of subnotebook computers, which will use 3-V IC technology to minimize power consumption. The XIP mechanism allows applications to execute directly from the PC card

ILLUSTRATION: DAVE CUTLER © 1992

to preserve system memory.

Along with the release 2.0 standard, the PCMCIA developed the Socket Services Interface Specification to establish a standard set of system calls for PC card operations. Socket Services forms a BIOS of sorts that allows a system to maintain hardware independence and ensure software portability. The PCMCIA introduced the first Socket Services specification (release 1.0) in August 1991; it released a slightly modified version (release 1.01) one month later. The PCMCIA has since made an effort to better define and enhance Socket Services functions and has beefed up support for protected-mode operation. Work on a higher-level software layer, called Card Services, commenced in early 1992 and was to be ratified as this article went to press.

Physical Definition

The PCMCIA standard defines a 68-pin connector that interconnects a PC card with a PCMCIA interface port in the host computer. The PC cards have a socket (female) connector, while the system interface ports use mating pin (male) connectors. The standard defines three different pin lengths for the system side of the interface. This design ensures that power is applied first and removed last when cards are inserted into and removed from a PC card port. This is necessary to guarantee reliable operation when inserting and removing PC cards in an electrically live socket.

The release 2.0 specification defines Type I and Type II card sizes (see figure 1). All cards measure 2.12 inches wide by 3.37 inches deep, but thickness varies. Type I cards are 3.3 millimeters thick. Type II cards measure 5.0 mm in the center but maintain a 3.3-mm thickness around the outer edges to remain compatible with system interface ports designed for Type I devices.

The PCMCIA recently defined a Type III card as an extension of the release 2.0 standard. This card is the same width and length but is 10 mm thick to accommodate large devices that cannot fit on Type I or II cards, such as Hewlett-Packard's new 1.3-inch hard drive. Like the Type II card, the Type III card maintains a 3.3-mm thickness at the outer edges, but it nonetheless requires a double-height slot.

Additional release 2.0 extensions stretch the length of Type I and II cards to 5.733 inches, leaving almost 2 inches protruding from the PCMCIA slot, and extend the height for the overhanging section to a maximum of 0.38 inch. This design is intended to support modem cards, which must include an RJ-11 jack and telephone-line transformer on-board.

PCMCIA PC CARD PIN ASSIGNMENTS

Table 1: *The signals assigned to the PCMCIA 68-pin connector all initially support memory-specific functions, but they can be switched to alternative functions for other types of cards.*

Pin number	Standard function (alternative function)	In/out?	Function description
1	GND	Ground	
2	D3	I/O	Data-bus bit 3
3	D4	I/O	Data-bus bit 4
4	D5	I/O	Data-bus bit 5
5	D6	I/O	Data-bus bit 6
6	D7	I/O	Data-bus bit 7
7	-CE1	I	Card enable
8	A10	I	Address-bus bit 10
9	-OE	I	Output enable
10	A11	I	Address-bus bit 11
11	A9	I	Address-bus bit 9
12	A8	I	Address-bus bit 8
13	A13	I	Address-bus bit 13
14	A14	I	Address-bus bit 14
15	-WE/PGM	I	Write enable
16	+RDY/-BSY (-IREQ)	O	Ready/busy or interrupt request
17	Vcc		Power
18	Vpp1		Programming supply voltage 1
19	A16	I	Address-bus bit 16
20	A15	I	Address-bus bit 15
21	A12	I	Address-bus bit 12
22	A7	I	Address-bus bit 7
23	A6	I	Address-bus bit 6
24	A5	I	Address-bus bit 5
25	A4	I	Address-bus bit 4
26	A3	I	Address-bus bit 3
27	A2	I	Address-bus bit 2
28	A1	I	Address-bus bit 1
29	A0	I	Address-bus bit 0
30	D0	I/O	Data-bus bit 0
31	D1	I/O	Data-bus bit 1
32	D2	I/O	Data-bus bit 2
33	+WP (-IOIS16)	O	Write protect or I/O port is 16-bit
34	GND		Ground
35	GND		Ground

The PCMCIA standard goes beyond mechanical dimensions to dictate the location of the write-protect switch, internal backup battery, vendor's label, and PCMCIA/JEIDA logos, if these items are present. Compliant PC cards must accept operating temperatures of between 0° and 55°C, storage temperatures of −20° to 65°C, and 0 to 95 percent relative humidity, noncondensing.

Electrical Specifications

Table 1 shows the signals assigned to the PCMCIA 68-pin connector. The PC card interface consists of a 16-bit data bus and a 26-bit address bus that supports direct addressing of 64 MB of memory. Several pins start out with functions specific to memory operations, but they can be reconfigured if the host device detects an I/O card. For example, pin 16 defaults to RDY/BSY (ready/busy) to support the programming of specific types of memory chips, but the host system can reconfigure it to be an IREQ (interrupt request) line when it detects the presence of an I/O card.

Electrically, all PC cards look like a memory card until the host system initializes them. The host system then changes the appropriate pin functions as necessary. Signals that were specifically added for I/O operations include IREQ, IORD (I/O read), IOWR (I/O write), INPACK (input acknowledge), SPKR (audio output), IOIS16 (16-bit I/O select), and STSCHG (status change). The PCMCIA specification also defines several signals for memory chip support, including Vpp1 and Vpp2 (two programming supply voltages), RDY/BSY, BVD1 and BVD2 (battery voltage detects), WP (write protect), WE/PGM (write enable/program), and RFSH (refresh).

For memory accesses, the OE (output

PCMCIA PC CARD PIN ASSIGNMENTS

Pin number	Standard function (alternative function)	In/out?	Function description
36	-CD1	O	Card detect
37	D11	I/O	Data-bus bit 11
38	D12	I/O	Data-bus bit 12
39	D13	I/O	Data-bus bit 13
40	D14	I/O	Data-bus bit 14
41	D15	I/O	Data-bus bit 15
42	-CE2	I	Card enable
43	RFSH	I	Refresh
44	RFU (reserved) (-IORD)	I	Reserved or I/O read
45	RFU (reserved) (-IOWR)	I	Reserved or I/O write
46	A17	I	Address-bus bit 17
47	A18	I	Address-bus bit 18
48	A19	I	Address-bus bit 19
49	A20	I	Address-bus bit 20
50	A21	I	Address-bus bit 21
51	Vcc		Power
52	Vpp2		Programming supply voltage 2
53	A22	I	Address-bus bit 22
54	A23	I	Address-bus bit 23
55	A24	I	Address-bus bit 24
56	A25	I	Address-bus bit 25
57	RFU (reserved)		Reserved for future use
58	+RESET	I	Reset
59	-WAIT	O	Extend bus cycle
60	RFU (reserved) (-INPACK)	O	Reserved or input port acknowledge
61	-REG	I	Register select
62	BVD2 (-SPKR)	O	Battery voltage detect 2 or audio-digital waveform
63	BVD1 (-STSCHG)	O	Battery voltage detect 1 or card statuses changed
64	D8	I/O	Data-bus bit 8
65	D9	I/O	Data-bus bit 9
66	D10	I/O	Data-bus bit 10
67	-CD2	O	Card detect
68	GND		Ground

enable) signal becomes the read strobe, while the WE/PGM signal operates as the write strobe. For I/O operations, separate IORD and IOWR signals exist for the read and write strobes. Two card-enable signals, CE1 and CE2, provide access to PC cards by enabling bytes at even-numbered and odd-numbered addresses, respectively. A multiplexing scheme, based on A0, CE1, and CE2, enables 8-bit host systems to access all data on D0–D7, if desired.

PC cards include a separate 64-MB memory-space area called *attribute memory*, which the host system accesses by asserting the REG (register select) signal. This special section of memory is distinct from main memory. In general, it's used to record card- and vendor-specific information such as card capacity and other configuration and attribute data. It's also used to access standardized card-configuration registers. The host system also asserts REG for I/O accesses.

While 3-V operation will become increasingly valuable as more systems based on 3-V IC technology appear on the market, PC cards placed into a 3-V system must start out operating with a 5-V interface. The system then configures the card for 3-V operation if the card supports it.

The Software Interface

To permit software access to PC card functions in a hardware-independent manner, the PCMCIA developed a set of system functions that applications can call by way of Card Services (see figure 2). At the most fundamental level, this consists of a group of functions called Socket Services. In a PC environment, you access Socket Services by way of interrupt 1Ah. Table 2 shows the Socket Services available in the current release 1.01 specification.

Socket Services views its resources in terms of adapters and sockets. An adapter is the hardware that connects the local computer bus to PCMCIA-compatible sockets, while a socket is the 68-pin interface connector into which you insert a PC card. A host system generally has only a single adapter, but it can support multiple adapters, and a single adapter can have multiple sockets.

The concept of memory-space windows is integral to the design of Socket Services. An area of a PC card's memory or I/O space is mapped into system memory or I/O space through a window—a reserved addressing range—that consists of zero or more pages. If a window is paged, all the pages within the window must be contiguous and of equal size. I/O-spaced windows are not paged.

Error detection is another important area. Some memory cards are EDC (error-detection code) generators, which means that they can detect memory errors. This is important for applications that want to ensure data integrity.

Socket Services reports the number of sockets, windows, and EDC generators for each adapter in a system. It can also report and alter the configurations of installed PC cards. While Socket Services provides access to all PC card features, it does not include all possible types of write/erase routines. Since there are many of these functions (called *memory technology drivers*), and since they are specific to the memory type and manufacturer, a higher-level software layer usually handles them.

In order to handle numerous data-recording formats and data organizations, the release 2.0 standard defines a metaformat that consists of a hierarchy of layers: physical (layer 0), basic compatibility (layer 1), data-recording format (layer 2), data organization (layer 3), and system-specific (layer 4).

The physical layer specifies the interface signals and electrical characteristics described above. The basic compatibility layer describes a minimal level of organization of the data on a PC card. All PC cards must support this layer by including a CIS (card information structure), which starts at location zero of the attribute memory space. The information in the CIS describes the card's organization, including memory type, size, speed, and other information. The data-recording-format layer specifies the PC card's data organization at the lowest level. The data-organization layer, one level higher, describes the logical organization of the data. The system-specific layer defines operations or interfaces specific to a particular operating environment.

Socket Services comprises six function categories. The nonspecific functions

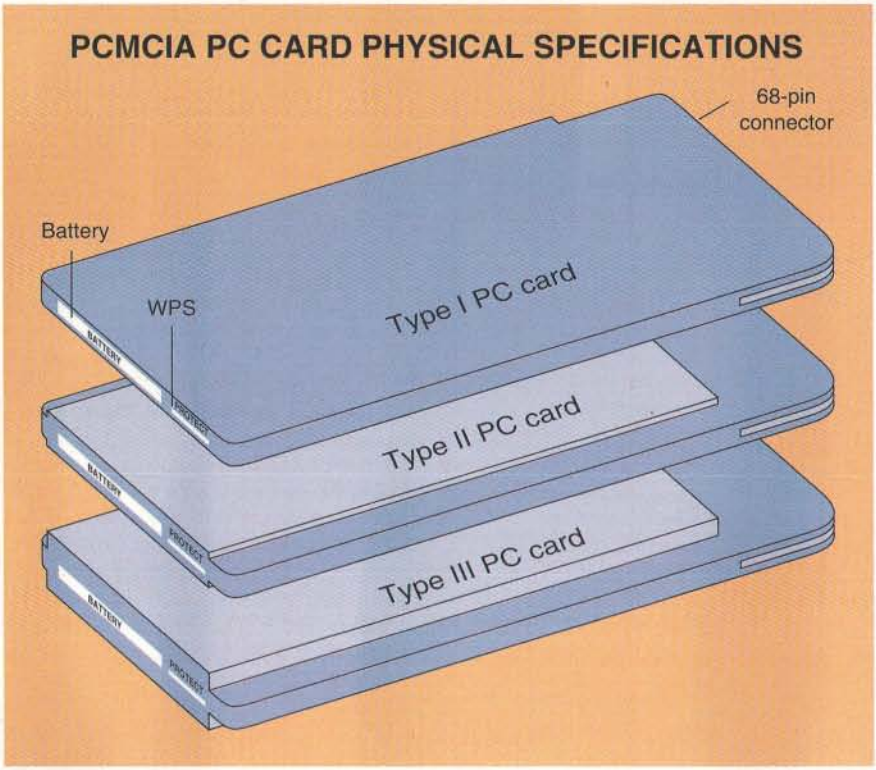


Figure 1: *The PCMCIA specifies three basic PC card sizes. All measure 2.12 inches wide by 3.37 inches deep. However, Type I PC cards are 3.3 mm thick, while Type II and Type III cards have thicknesses of 5 mm and 10 mm, respectively. The Type II card fits into any PCMCIA slot; the Type III card requires a double-height slot.*

handle such operations as determining the number of adapters in the system and establishing callback routines (called when card status changes or invalid writes are detected).

The adapter functions return the Socket Services version number, return information about a particular adapter, and permit adapter configuration. The socket functions are similar but work with sockets (cards) instead of adapters. The card functions go a step further to support card read and write operations, which can be part of programming operations. The window functions handle PC card window and page manipulations. Finally, the EDC functions determine the EDC capabilities of the installed cards and can configure, enable, and disable EDC operations.

Card Services

Socket Services is the lowest software layer of a multilayer software hierarchy. Higher layers may be operating-system specific and may allow the creation of virtual Socket Services, so that any PC card can be shared by multiple processes. Seeing the need to specify the next layer above Socket Services, the PCMCIA working group began work on the Card Services specification in early 1992 and was to present the specification's first release in September. Card Services controls the operation of individual cards by sending transactions over the bus via Socket Services.

continued

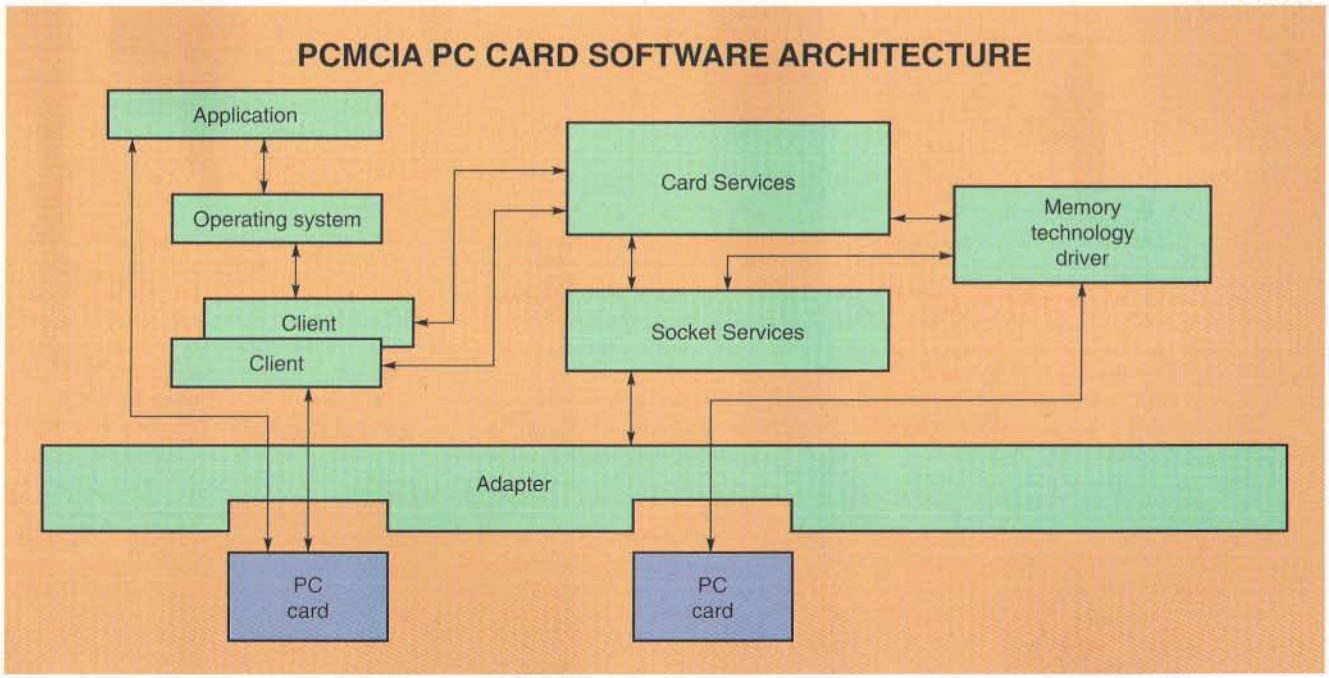


Figure 2: *The PC card architecture consists of one or more implementations of low-level (hardware-dependent) Socket Services, which interact directly with PC card adapters. Card Services provides PC card access to programs (clients) running in the system and coordinates PC card resource use between clients.*

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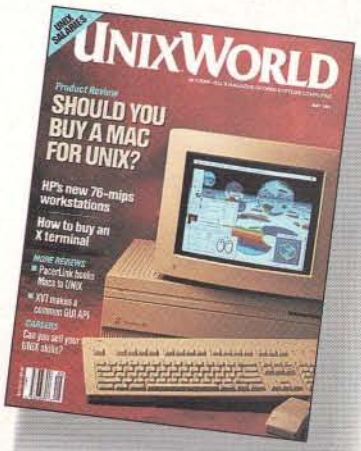

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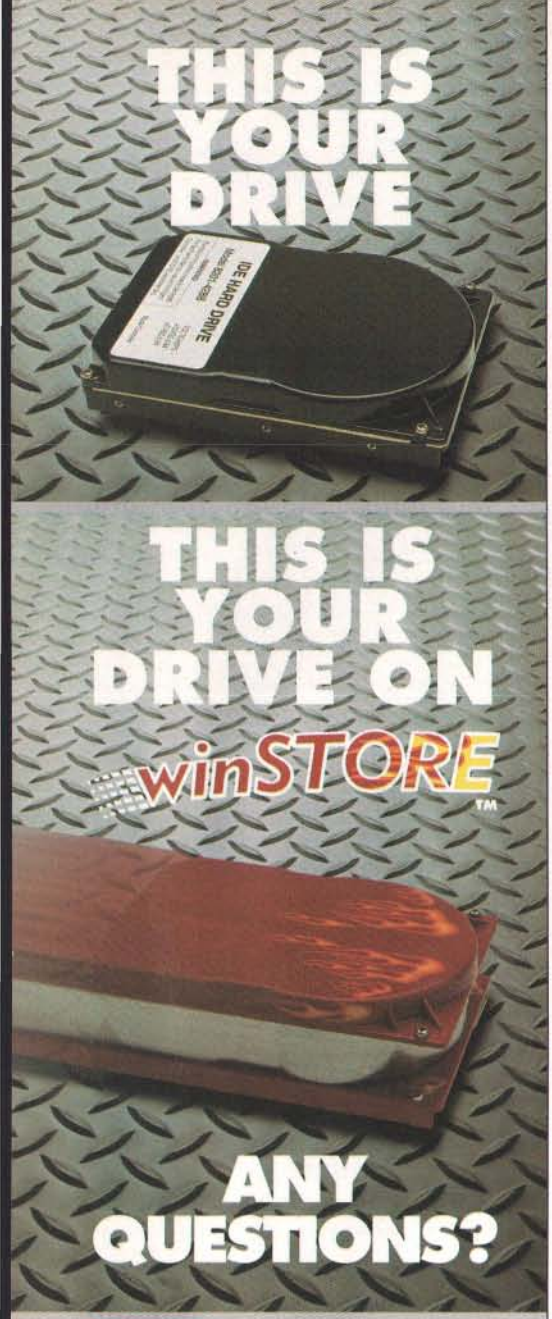

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Card Services acts as the liaison between multiple clients (tasks running in the system) and PC cards, sockets, and other system resources. All client tasks must make calls to Card Services to access PC card functions, which in turn make the necessary Socket Services calls to effect the requested operations. While a system can have multiple distinct implementations of Socket Services to accommodate multiple adapters in a system (Socket Services is hardware-dependent), only a single implementation of Card Services can be present in a system. Card Services coordinates all requested PC card operations when multiple Socket Services implementations are present.

Intel, an active PCMCIA participant, has defined its own software interface environment that replaces Card Services. The *exchangeable card architecture*, or ExCA, predates Card Services and was the model on which much of the Card Services was based. ExCA remains a superset of the defined PCMCIA functions and, with certain modifications, may at some point become a more integral part of the PCMCIA standard.

Compatibility Snags

The PCMCIA standard is proving its importance in the development of subnotebook systems. The push for so much functionality has not, however, been without its problems.

The definition of the PCMCIA software interface lagged behind the relatively solid physical-interface definition. As this article went to press, the dust was still settling on the latest revisions to Socket Services and Card Services. Several companies, including Phoenix Technologies and SystemSoft, had already developed Socket Services code for use in PCs. With over 50 suppliers preparing to rush PCMCIA-compatible products into production in time for Fall Comdex, the potential for PC card compatibility problems loomed.

PCMCIA executive director Brendan McGuire dismissed such speculation. He claimed that these concerns are overstated, that the software is mature, and that most vendors have designed their systems to easily accommodate any upgrades that are made to the Socket Services and Card Services. Any problems that arise should be short-lived, as vendors quickly revise their software.

PCMCIA cards are considerably more expensive than standard PC add-in boards. For example, a 2400-bps data/fax modem card was selling for approximately $300 at press time, versus about $99 for a typical AT-bus card. And solid-state memory costs quite a bit more per megabyte than

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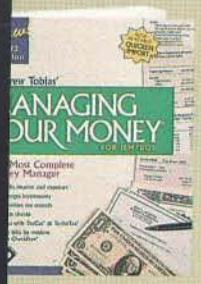

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Register status callback	Registers a callback routine to be invoked at status changes.
Register card technology callback	Registers a callback routine to be invoked at write request to a card that doesn't support Write multiple.
Adapter functions	
Get Socket Services version number	Returns version number of current Socket Services handler.
Inquire adapter	Returns information for a particular adapter.
Get adapter	Returns the current configuration of the specified adapter.
Set adapter	Sets the configuration of the specified adapter.
Window functions	
Inquire window	Returns information for a particular window.
Get window	Returns the current configuration of the specified window.
Set window	Sets the configuration of the specified window.
Get page	Returns the current configuration for a particular window page.
Set page	Sets the status for a particular window page.
Socket functions	
Inquire socket	Returns information for a particular socket.
Get socket	Returns the current configuration for the specified socket.
Set socket	Sets the configuration for the specified socket.
Card functions	
Get card	Returns the status of a particular socket.
Reset card	Resets a particular card.
Read one	Reads 1 byte/word from a particular socket.
Write one	Writes 1 byte/word to a particular socket.
Read multiple	Reads multiple bytes/words from a particular socket.
Write multiple	Writes multiple bytes/words to a particular socket.
EDC functions	
Inquire EDC	Returns the capabilities of specific EDC hardware.
Get EDC	Returns the configuration of an EDC generator.
Set EDC	Sets the EDC configuration.
Start EDC	Starts a previously configured EDC generator.
Pause EDC	Pauses EDC generation on an operating EDC generator.
Resume EDC	Resumes EDC generation on a paused EDC generator.
Stop EDC	Stops EDC generation on an operating EDC generator.
Read EDC	Reads a calculated value from the EDC hardware.

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ACKNOWLEDGMENT

Thanks to Brendan McGuire, executive director of the PCMCIA, for his help in preparing this article.

Roger C. Alford, a BYTE consulting editor, is president of Programmable Designs, a Michigan-based electronics design services firm. You can reach him on BIX as "rogera."

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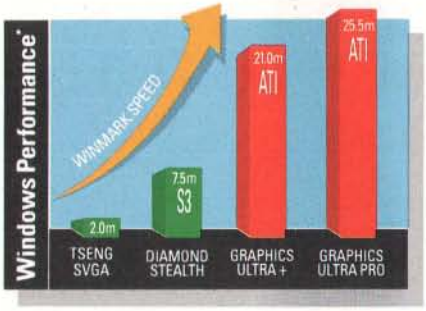

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WRITING A WINDOWS DLL

A simple debugging aid demonstrates useful DLL techniques

Most of the principles of the dynamically linked library are as old as computing itself. For example, in the early days of computing, commonly used routines on mainframes were grouped into core libraries, so called because they resided in the magnetic core of the computer. These libraries decreased the amount of program storage space needed and boosted execution speed. Even today, many mainframe operating systems, such as Prime's PRIMOS, maintain vast virtual-storage libraries that can be modified and enlarged by both end users and authorized support personnel. Unix, too, has adopted shareable libraries, which serve a purpose similar to that of Windows DLLs.

Windows (along with OS/2 and Windows NT) offers a flexible and elegant form of dynamic linking that has key advantages for software development and product support. Unfortunately, until recently, writing a Windows DLL was a complicated and mentally taxing exercise. DLLs require some fancy footwork in terms of static and dynamic data. Moreover, since you can call a DLL from a different language than that used to write it, you may need to think about two sets of calling conventions—one for functions within the DLL and a possibly different one for functions exported to the DLL's clients. These design and coding considerations make DLLs much trickier than traditional statically linked libraries.

As "dynamically linked" implies, the code for a DLL is not bound to an executable file at the time the program is linked. Rather, a program called an *import librarian* extracts a pseudolibrary from the DLL for use by the linker. This pseudolibrary is used to resolve library calls from another module at link time. The actual DLL file, which comes into play at run time, must reside in the current directory, on the DOS path, in the Windows directory, or in Windows' SYSTEM subdirectory.

In this article, I'll develop a simple DLL that exports `puts`-like and `printf`-like functions. Clients can use these functions to post messages to a listbox maintained by a listbox server program working with the DLL. Before I dive into the code, though, I'll review some Windows programming basics from a DLL perspective.

Module Definition Files

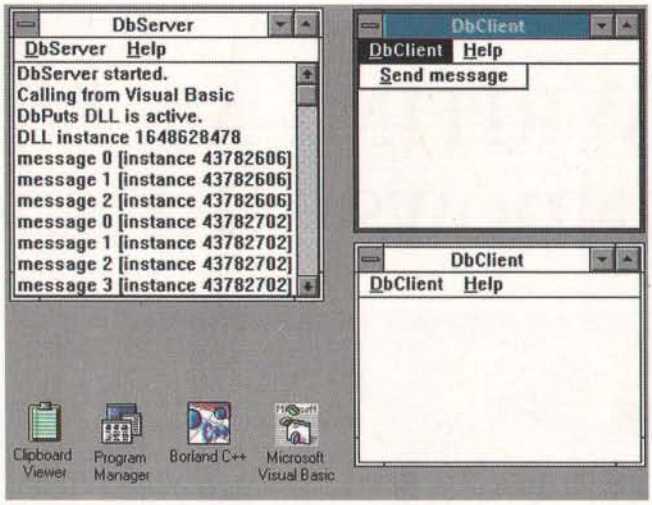
Most development environments, including the Borland and Microsoft C/C++ products, use module definition files to describe key characteristics of ordinary programs and DLLs. Like Intel assembly pseudo-ops, these .DEF files produce no code directly. They tell the linker and run-time operating-system loader about the DLL's requirements. Some statements in the .DEF file just name and describe the module. Others inform the linker about segment names and properties (e.g., the size of the stack and heap, whether to preload code and data, and whether to tag code and data as movable or discardable). Still others enumerate and define entry and exit points (i.e.,

ILLUSTRATION: DAVE ROTOLONI © 1992

imports and exports).

DLLs share many of the same .DEF statements as normal Windows programs. The most notable exception is the STACKSIZE parameter, which should not be specified, since a DLL uses its caller's stack.

Whether you are writing a Windows program or a DLL, the information in the module definition file is vital. For the novice Windows programmer, a few hours studying the special syntax and layout of the .DEF file will be well spent.



DBSERVER displaying messages from itself, a Visual Basic program, DBPUTS, and two instances of DBCLIENT.

Resources and DLLs

Like ordinary Windows programs, DLLs can have resources attached to them via the resource compiler. Resources are static data that your program uses—icons, bit maps, cursors, and strings. Although most DLLs don't include resources, some (e.g., Windows 3.1's MOREICONS.DLL) exist solely as resource containers. Even though you may never need to write a DLL that maintains its own static resources, it's still interesting to note that DLLs can do so if required.

Early and Late Binding

Late binding—the ability to link to code at run time—is often cited as a key advantage of object-oriented environments. While most DLL clients bind early by linking against an import library, there is an alternative mechanism that supports late binding. A program can call `LoadLibrary` to pull a DLL into memory and then call `GetProcAddress`, which dynamically acquires a function exported by the DLL.

This technique is especially useful when multiple versions of a library exist and the user chooses a particular version at run time. Microsoft Word for Windows' file-import filters, for example, are a set of DLLs that implement a set of common routines used to import text from a variety of foreign file formats into Word (see "Object-Oriented DLLs" in this issue).

Quirks and Oddities

DLLs can be more than a little quirky. As I've noted, a DLL uses the stack segment of its caller. This arrangement has some curious ramifications.

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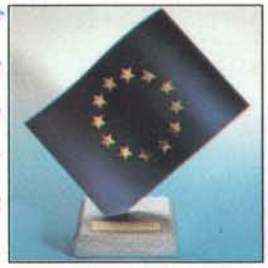

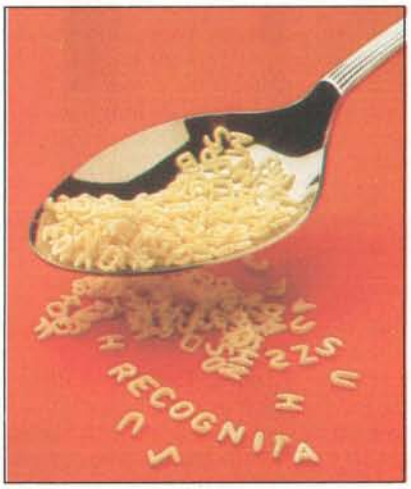

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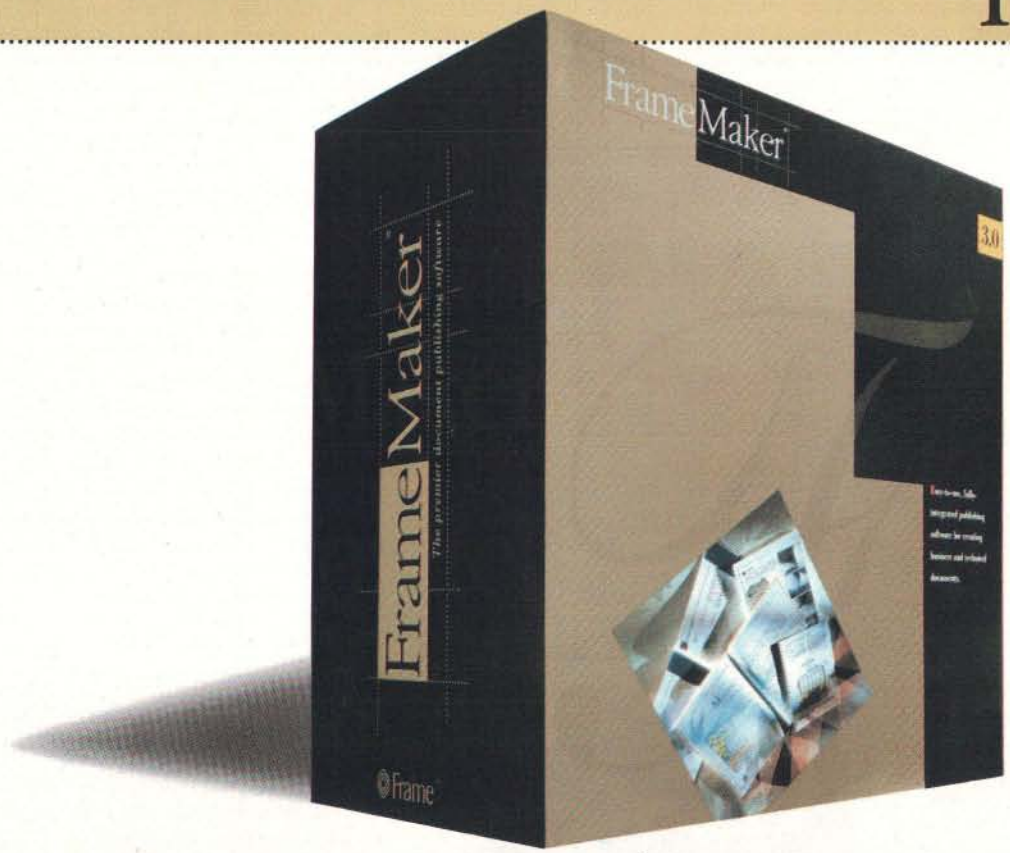

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Like normal Windows programs, DLLs are subject to segment-size limits for both code and data. Although that limit is 64 KB, a 4-KB or 16-KB segmentation policy may be preferable in 386 enhanced mode. Using 4-KB segments can help the Windows memory manager work more efficiently, since its paging mechanism is also based on 4-KB units. Although segregating code and data into 4-KB segments may seem like a mundane exercise, it is one way to squeeze performance out of a large Windows application.

Functions that a DLL will export to clients (or to Windows itself) must be defined using the keywords FAR and PASCAL: FAR because the function can be called from any point in the Windows code space, and PASCAL because that calling convention is the lingua franca of Windows. (The PASCAL calling convention is that function parameters pass left to right and that the callee, not the caller, cleans up the stack.)

Once in the DLL's code space, you can use any calling convention you like for internal (nonexported) functions. This convention is typically either that of C or Pascal, but others are possible. Windows will allow any convention within your own code space, but FAR PASCAL (known as CALLBACK in the Windows 3.1 header file) must be specified for functions Windows will call. To reference data and code in the DLL itself, both far and near pointers to local data can be used as required. Far pointers are preferable, mainly because they fully qualify an object without the need to refer to the ever-shifting CS (code segment) or DS (data segment) registers.

Segmentation Issues

I'd like to clear up some of the mist surrounding what kind of memory is used for which types of data in a Windows DLL. Typically, the SS register points to the stack segment of the caller. The data placed on the caller's stack includes parameters to DLL functions, as well as automatic data allocated by the DLL functions.

Unlike in a regular Windows program, a second stack area is granted to DLLs by Windows. Known as the *local heap*, this second stack area is referenced from within a DLL via the DS register. Windows puts all DLL resources and static data here, as well as memory allocated by way of calls to `malloc` or `LocalAlloc`.

Having two separate data segments for automatic and static data allows for some more breathing room in a Windows DLL, but it greatly complicates matters when the DLL must call other libraries or statically linked support routines. Those routines typically assume the SS (stack segment) register points to the same place as the DS register—a traditional assumption for both DOS and Windows code. Because DLLs violate that assumption, early Windows DLL developers often had to write their own unique library routines to work inside DLLs. These routines typically used far pointers to fully qualify an object without the need to refer to any of the segment registers, or they merely assumed that they were to use the DS register rather than SS.

Fortunately, Borland and Microsoft (and other vendors) now offer complete, robust, standard libraries for Windows. These libraries work adequately under both DLLs and standard Windows applications. Consequently, the DS != SS problem surfaces only when DLLs are used for certain activities, like interprocess communication or mixed-memory-model programming.

Resource Ownership

When memory is being allocated from within a Windows DLL, the question of

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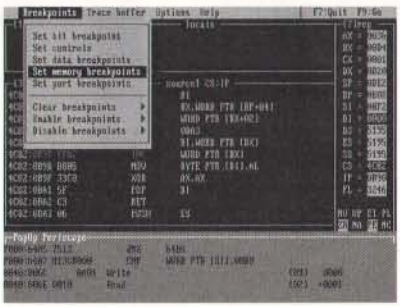

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Listing 1: *The exported library routines.*

```
#include <windows.h>
#include <stdio.h>
#include <stdarg.h>
#include <string.h>
#include "dbserver.h"
#include "dbputs.h"

BOOL FAR PASCAL EnumFunc(HWND, LONG);
HWND hWnd = (HWND) NULL; // DBSERVER's window
HANDLE  hLi;WORD wSS, wHeapsz;LPSTR lpParam;

int FAR PASCAL LibMain(HANDLE hi,WORD wSSw,
WORD wHszw,LPSTR lpCmdLine) {
WORD wReturn = WinExec("dbserver", SW_SHOW);
  if (wReturn < 32) {
    MessageBox(GetFocus(),
     (LPSTR) "DbPuts: could not start server",
     "Error", MB_ICONSTOP);
              } else {
    hLi = hi; // Save instance handle
    wSS = wSSw; // Save SS of caller
    wHeapsz = wHszw; // Local heapsz
    lpParam = lpCmdLine; }
  return(TRUE);}}

int FAR PASCAL WEP(int EventCode) {  return 1; }

HWND FAR PASCAL SetHandle(HWND hWndIn)
  {  if(!hWnd) EnumWindows(EnumFunc, (LONG)
hWndIn);
  return hWnd; }

int FAR PASCAL DbPuts(LPSTR message) {
  size_t sLength;
  if(!hWnd) return NULL;
  if(!message) return NULL;
  sLength = strlen(message);
      if(sLength)
    PostMessage(hWnd, WM_COMMAND, MSG_SIG1,
     (LONG) GlobalAddAtom((LPSTR) message));
  return (int) sLength; }

int FAR PASCAL DbSprintf(LPSTR message,...)
  { static char chBuffer[1024];
  WORD sLength;va_list pArguments;
  if(!hWnd) return NULL;
  if(!message) return NULL;
  va_start(pArguments, message);
  sLength = vsprintf(chBuffer, message,pArgu-
ments);
  va_end(pArguments);
  sLength = strlen(chBuffer);
  if(sLength)
    PostMessage(hWnd, WM_COMMAND, MSG_SIG1,
     (LONG) GlobalAddAtom((LPSTR) chBuffer));
  return (int) sLength; }

BOOL FAR PASCAL EnumFunc(HWND hwnd, LONG lParam)
  { if (hwnd == (HWND) lParam)
    { hWnd = hwnd;return FALSE;}
  return TRUE;}

void FAR PASCAL CheckDLL() {char buf[80];
  // Example of a DLL resource being used;
  LoadString(hLi, IPL_MESSAGE, buf, 80);
  // We, too, can use our own DLL functions;
  DbPuts(buf);DbSprintf("DLL instance %ld",hLi);
}
```

resource ownership arises. Since a DLL can be shared by many Windows applications, who actually owns the data once it's allocated? In the case of `LocalAlloc` (or `malloc`), the answer is straightforward: Since `LocalAlloc` returns pointers relative to DS, the DLL itself owns this data. That means that any handles returned from calls that allocate resources within the DS stack of the DLL will be valid only when processed by the DLL itself.

In the case of `GlobalAlloc`, however, the argument for ownership is less clear-cut. Suppose you are allocating global memory for a callback function or other Windows application. If the newly allocated DS were to belong to a DLL, it would be freed when the DLL was unloaded. This could be disastrous if the callback function or Windows application attempted to use memory that was no longer available. Conversely, if that same DS belonged to the program that called the DLL, then the DLL would crash if its first caller (and the owner of the segment in question) freed the memory while the DLL was still using it to service the requests of another Windows application. If memory is not to be locked at all times, how do you allow it to be shared properly?

To address this problem, the `GlobalAlloc` call supports two special flags, GMEM_SHARE and GMEM_DDESHARE. As their names imply, these flags allow any allocated DS to be shared with other programs without risking a protection violation. When used from within a DLL, these flags also solve the ownership dilemma. If neither flag is specified in the call to `GlobalAlloc`, then the resulting handle to the DS in question belongs to the currently active instance of the application that called the DLL. When that instance terminates, the memory is freed automatically. However, when either GMEM_SHARE or GMEM_DDESHARE is specified, the newly allocated DS will belong to the DLL, not to its caller.

Inside DBPUTS

Given this background, look at the sample DLL application, DBPUTS.DLL (see listing 1). The library exports versions of the `puts` and `printf` functions, in collaboration with a server application that provides a scrolling, resizable listbox in which messages accumulate. DBPUTS exports six functions: `LibMain`, `SetHandle`, `DbPuts`, `DbSprintf`, `CheckDLL`, and WEP. Two of these appear in every DLL: `LibMain`, the standard DLL entry function, and WEP, the standard exit function. The others are the meat of DBPUTS.

`SetHandle`'s job is to synchronize DBPUTS with DBSERVER, the standard Windows application that provides the listbox in which clients of DBPUTS insert their debugging messages. Although a DLL can operate its own user interface (typically in the form of dialog boxes), I found it more convenient to let DBPUTS parasitically exploit the user-interface machinery of a full-fledged Windows application. To this end, DBPUTS exports `SetHandle`, which, when called by DBSERVER, enables DBPUTS to acquire a handle to DBSERVER's application window. The DLL can then use that handle to pass on data received from its clients to the listbox server. Using the Windows `EnumWindows` routine within `SetHandle` enables the DLL to confirm that the handle passed to it belongs to a top-level window—it's just a sanity check.

DBPUTS launches DBSERVER by calling `WinExec`. If the server fails to launch, it alerts you by means of a message box. How can DBPUTS, a DLL that doesn't maintain its own window, supply the `MessageBox` call with an appropriate

handle? The solution I've used is to call GetFocus in order to "borrow" the handle of the active window.

After SetHandle has stored the handle to the listbox server locally, any Windows program that binds statically or dynamically to DBPUTS can issue calls to its two service routines, DbPuts and DbSprintf. DBSERVER calls DbPuts to announce its successful initialization, like this:

```
DbPuts("DbServer started.");
```

DBCLIENT, a sample client of DBPUTS, uses the DbSprintf call

```
DbSprintf("message %d
 [instance %ld]",
  times++,hInst);
```

to relay two numbers: a count of its calls to DbSprintf, and its instance handle. (Since messages from all clients appear interleaved in DBSERVER's listbox, the instance handle differentiates multiple instances of DBCLIENT.)

Finally, DBPUTS.DLL can call its own functions to place messages in DBSERVER's listbox. Its CheckDLL function does this in response to DBSERVER's corresponding menu option; this enables a user of DBPUTS to verify that the library is available and working properly. On the screen on page 248, DBSERVER displays messages from itself, from DBPUTS, and from two instances of DBCLIENT.

DBPUTS relays its client's string to DBSERVER by creating a *global atom* (an entry in a special table of strings available to all Windows programs) and then posting a WM_COMMAND message to DBSERVER. The first parameter of the message instructs DBSERVER to retrieve and display the string that DBPUTS attached to the atom; the second is the atom itself. When it receives that message, DBSERVER extracts the string, deletes the atom, and then in turn sends messages to its own listbox that cause the string to be inserted and highlighted. In fact, DBSERVER does most of the hard work; DBPUTS merely relays messages to DBSERVER. Yet, as a DLL, DBPUTS provides the crucial link between DBSERVER and a host of potential clients.

If you call the DBPUTS functions in rapid-fire succession from inside a loop, you'll find that DBSERVER displays no more than eight of them. That's because DBPUTS uses the asynchronous PostMessage, rather than the synchronous SendMessage, to send its messages to the server. PostMessage drops messages in the target application's queue and returns immediately. But that application can't process the messages until the sender yields the CPU, and the queue fills up after eight messages. One solution is to have DBPUTS call Yield periodically. Another is to use SendMessage to synchronize the communications. In that scenario, each call to DBPUTS would halt the calling program until DBSERVER had processed the message.

For performance, I chose the asynchronous approach using PostMessage. If you want to call DBPUTS repeatedly from within loops, switch to SendMessage.

DLL Constructors and Destructors

It's time to explain the two obligatory DLL support routines, LibMain and WEP. Like WinMain (the entry point to a standard Windows program), LibMain returns either TRUE or FALSE, depending on the success or failure of initialization. As such, it's analogous to a C++ or Object Pascal constructor. The four parameters to LibMain are a little bit unusual, even for a Windows callback function. They are the

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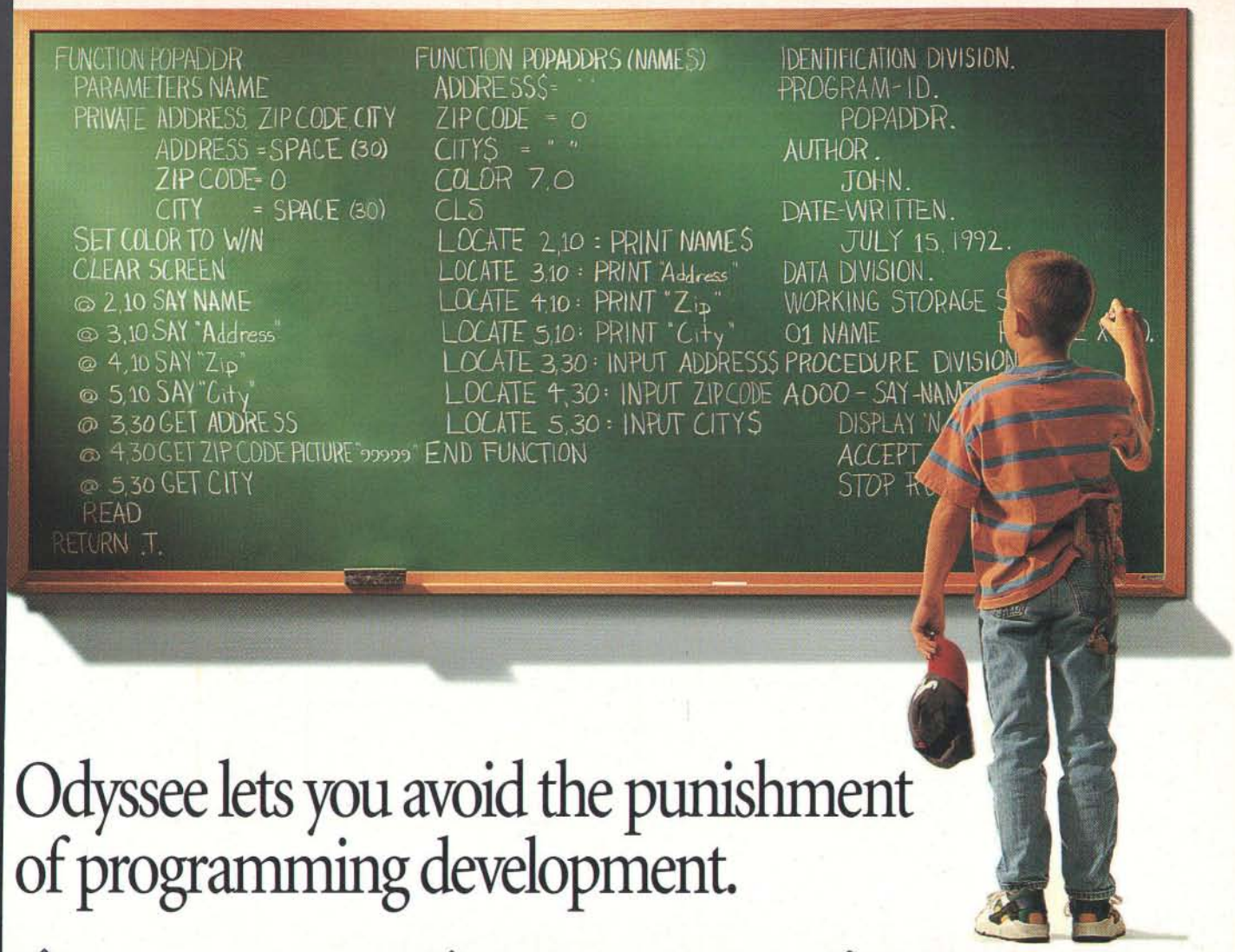

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library's instance identifier, its DS, the size of its own local heap, and the command-line buffer used to invoke the DLL.

That's right—the command line. It's a little-known fact that DLLs can load actively, just like normal Windows programs. In fact, Informix Wingz 1.1 and 2.0 use a form of this "active loading" feature to allow users to write their own C functions and libraries, which can be called from the built-in Wingz command language, Hyperscript. This feature of Wingz (and Windows) is another form of late binding, as no .DEF or .LIB files are required for calling external, user-provided libraries.

The first two parameters—the value of the DS register and the size of the DS (in bytes)—are passed to `LibMain`. Since `LocalAlloc` uses this local heap segment, it's a good idea to compare its size to the DLL's estimated run-time requirements before returning TRUE to Windows. The module definition directive HEAPSIZE can manipulate the number of bytes allocated to the local heap, as can Windows' `LocalInit` function.

The values of DS and `hInstance` could be useful when supporting multiple DLL invocations. Currently, though, Windows is highly serialized and supports activation of only one instance of any DLL.

When examining the size of the local stack (i.e., DS), don't forget about resources your DLL may need to load. Make sure that everything you need will fit into the DS heap area. Once control reverts to Windows, of course, Windows can swap out any unneeded resources, just as it does for ordinary Windows applications. If, for some reason, `LibMain` returns FALSE to Windows, the library will not load, and the calling application will terminate gracefully—in other words, the user will be notified by means of a message box.

The `WEP` function serves as the DLL's destructor—a mechanism for releasing memory and other resources before exiting. If you don't have cleanup to perform, you may not have to include a `WEP`, since compilers like Borland's will automatically include a generic one for you. I've included one in DBPUTS just for completeness.

DLLs in Perspective

Most of the headlining features of Windows 3.1 are packaged as DLLs and, as such, can be retrofitted to Windows 3.0. Registered users of Windows 3.0 aren't required to upgrade their version of Windows; they can take advantage of advanced 3.1 features by merely adding in the 3.1 DLLs, which vendors are actively encouraged to redistribute. Common dialog boxes, DDEML, and OLE are just a few of the recent 3.1 innovations that can be retrofitted into Windows 3.0 by merely copying the required DLLs into Windows 3.0's SYSTEM directory.

Though a simple example, DBPUTS nicely illustrates the power of DLLs. For the price of a few function prototypes and an extra link argument (or a call to `LoadLibrary` and `GetProcAddress`), any Windows application can post simple or formatted debugging messages to a convenient on-screen bulletin board. ■

Editor's note: *The complete listings described in this article are available in electronic format. See page 5 for details.*

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AUDIT YOUR LAN

LAN inventory tools help track your network configuration

Users call upon network administrators to solve problems, even if those problems are only tangentially related to the network. The first step in resolving such issues is to take an inventory to determine where conflicts may lie. You can do this by walking from workstation to workstation, recording configuration files, and running diagnostic utilities, but you won't want to do it often—and configuration information is most valuable when you track it on a regular basis.

I wrote two LAN inventory programs to make the recording of user configurations more automatic. The programs are called PROBE and LANDB. Both run on each workstation on the LAN, writing configuration information to files in a shared network directory. They record processor type and speed, the amount of RAM installed, free disk space, user IDs, CONFIG.SYS and AUTOEXEC.BAT contents, and other useful parameters.

PROBE produces a unique file for each workstation. The file contains text entries that describe the workstation in detail. PROBE names its output files according to the unique node address burned into the network adapter, with an extension consisting of the first three characters of the user ID for the person who uses that workstation.

LANDB writes to a single shared file (i.e., LAN.CSV), no matter what workstation it runs on. Each line of LAN.CSV is a comma-delimited series of fields that describe a particular workstation. You can import this text file into a database manager such as Borland's Paradox. LANDB creates a new record in LAN.CSV each time it's run.

PROBE and LANDB recognize both IPX-based (i.e., NetWare) and NetBIOS-based (e.g., LAN Manager, LAN Server, and LANtastic) LANs, providing information about both kinds of environments. LANDB contains file-sharing logic to prevent LAN.CSV collisions if two or more instances try to write to the shared database at the same time.

You can run PROBE or LANDB in the batch file that gets a workstation onto the LAN, but that means visiting each workstation to update batch files. There's an easier way: You just invoke PROBE or LANDB in the system log-in script for your network. On my network, I set up the log-in script to run PROBE and LANDB every Tuesday.

With command-line parameters, you can tell both LANDB and PROBE which shared directory to use, so they'll write output files to a central location on the file server. (Make sure all your users have full rights to that directory.) After you run PROBE for a day, you'll accumulate a directory of files with one file for every workstation that logged in. Or, if you run LANDB, you'll have a single file with entries for each log-in.

I used Microsoft C 6.00A to write these programs. The C code is totally generic—you could use almost any C compiler—but the logic that determines CPU speed is compiler-dependent. I used a timing loop to measure CPU speed, and the number of loops obviously depends on the machine code emitted by the compiler. You'll need to recalibrate the CPU speed table if you use a different compiler. ■

MAC/Tom Thompson

Trimming the Fat from System 7.0

One of the best talismans you can use to keep the Bomb Beast at bay is a crash disk—a bootable floppy disk with disk-recovery utilities. When your Mac refuses to start after a crash, you just poke in the floppy disk, restart, and begin recovery procedures. Unfortunately, this strategy falls apart with System 7.0, which requires 1.3 MB of storage on a bootable volume. This leaves you only 100 KB left to pack anything else on a 1.44-MB bootable floppy disk.

Frank Probul has created a shareware Installer script (available for $15) that trims nonessential resources (e.g., color icons, Balloon Help, SANE [Standard Apple Numeric Environment], and network drivers) from the System file, freeing an extra 200 to 300 KB of space. I've used this script to make a bootable floppy disk that includes Disinfectant 2.9. This works reliably on the Mac II, Mac IIci, PowerBooks, and Quadra 950.

UNIX/Ben Smith

Saving Face

For several years now, the Usenix organization has been encouraging attendees at its conferences to save face—to have the image of their face recorded for the faces database. The project is geared to humanizing communication around the worldwide Unix network and to adding graphics to appropriate Unix utilities.

The face-image viewer is a program named xface, an X Window System client program. The collection of utilities, called faces, is maintained by Rich Burridge of Sun Microsystems (Australia) and is available on most Unix archive servers and BIX.

Faces works like this: You store your character-based compressed image in your home directory and instruct your mail-composing program to include a pointer to this file. Whenever you send an E-mail message, your image is included.

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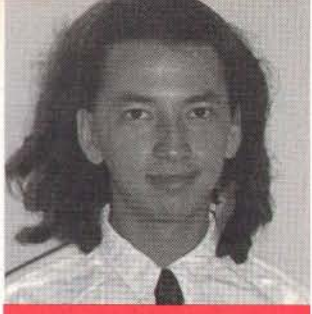


GEN
KIYOOKA

OBJECT-ORIENTED DLLS

Some say that Windows' architecture is less than elegant, but I still marvel at the transformation from Windows 3.0 to 3.1. A host of new functions and data types appeared: DDE management, OLE, common dialog boxes, and more. DLLs made the complexity manageable. Each new library added a group of APIs and, more important, a new object, class, or abstract data type. As a result, Windows, in the midst of growth, remained organized and comprehensible.

Of course, the design of operating-system software is an ambitious and difficult undertaking, so it makes sense that Windows' engineers would take the time to partition their problem space in a tasteful manner. But what of the ordinary Windows applications programmer? Is the extra effort really required?

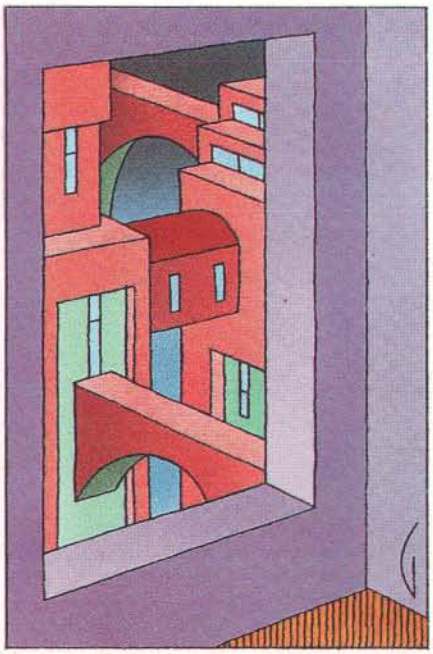
Consider Microsoft Word for Windows' import filters, which are organized as a set of DLLs. Don't be fooled by the .CNV filename extensions. If you run EXEHDR (the Microsoft C .EXE snooper) against Word's filters, you'll find that they're really DLLs that export functions. Even more interesting, you'll find that each filter exports a consistent set of functions: GETINIENTRY, INITCONVERTER, FOREIGNTORTF, RTFTOFOREIGN, and ISFORMATCORRECT.

When you ask Word to import a file whose format is foreign, it enumerates the filters listed in WIN.INI. When you pick one, Word loads the library and stuffs the addresses of its functions into a table of function pointers, neatly TYPEDEFed to enforce strict type checking. Knowing nothing of the filter's inner workings, Word simply asks it to perform a file conversion. After kicking things off with a call to INITCONVERTER, Word might then use ISFORMATCORRECT to verify the contents of the foreign file as an appropriate match for the DLL and FOREIGNTORTF to create an intermediate representation of the data in the RTF (Rich Text Format) that Word can use.

Once the requirements for a file converter are defined and documented, any Windows programmer can write an import filter. Because Windows itself defines parameter passing and calling conventions for DLLs, a filter can be written as easily in Pascal as in C. Interface elements such as dialog boxes, menus, and bit-map files can be bound into the module. Initialized, static data lives in its default data segment. If data packets are rigorously abstracted to HANDLE types, the private workings of the DLL and host application become opaque to one another.

From this perspective, a DLL is more than just a code repository. It's a distributable, reusable object. In the case of the WinWord import filter, that object abstracts the type *foreign file* represented by a file handle and wrapped with a template of method definitions that describe the operations on the type foreign file. The variation in type of the foreign file (i.e., its subclasses) is represented by instantiations of the DLL description—the individual .CNV files. Because the requirements of the interface between the converter and Word have been formalized, and the relationship between them conveniently decoupled via dynamic, run-time linking, any number of converters can be independently produced, tested, and distributed.

Dynamic link libraries encourage object-oriented design



To the delight of software engineers and academics alike, effective software design with DLLs shifts the emphasis toward early specification, abstraction, and interface design. Just any old DLL won't do. A correct interface is of paramount importance, because it governs how application components interact. A large software project may be designed and implemented as a collection of DLLs. With a rigorous specification, teams or individuals can work independently.

Designing DLLs

Designing a first DLL interface can be a daunting task. One approach is to study what other developers have done. All you need is the EXEHDR utility and a working version of the applications software. Even a crippled demonstration program retains the peculiar architecture of its commercial counterpart and, as such, makes for a low-cost study tool suitable for spelunking with EXEHDR. The Windows API, in all its splendor, is another suitable avenue for exploration.

For the ultimate in late binding, you can exploit run-time dynamic linking, as Word's import filters do. That means the calling application doesn't even discover the name of the DLL—let alone resolve its entry points—until run time.

Alternatively, you can bind the DLL's name into your program and resolve the

ILLUSTRATION: JOE GAST © 1992

DLL's entry points in advance, using the linker. In this model, you can alter your program's behavior by swapping in any DLL that has the right name and exports the right set of functions. The name of the module becomes an attribute of the formal definition of the interface. This technique is less flexible than the run-time approach, but it's also simpler. You don't have to build and maintain a list of function pointers, because the linker does that for you. Use this approach to distribute incremental software updates or to outfit an application for multiple versions. Consider, for example, a network-aware application that can run over NetBIOS, SPX/IPX, or TCP/IP protocols. You might choose among protocol modules during installation and never again need to change that DLL.

In larger projects, you'll have to make a basic design decision. Should your DLL export a few complex functions or many simple ones? I've just lent a helping hand to an application design that required such a decision. I helped the architect weigh the pros and cons of each approach. In this case, it was necessary to design a DLL that would expose nearly every aspect of the application's behavior to modification by the user. We decided that a single polymorphic entry point would serve our needs best.

This entry point would take just two parameters: an integer representing an event and a 32-bit word whose meaning depended on the event passed in the first parameter. At every stage in the execution of the application, we would arrange to send events to the DLL by way of this polymorphic entry point. The definition of each event would include a definition of the data passing through in the 32-bit parameter.

We chose this method so we'd be able to add and remove events without continuous modification to a group of DLLs dispersed geographically among the future installed base, potentially (we hoped) thousands of users. Another benefit was that trivial implementations of the DLL, ones that handled only a subset of the application's events, wouldn't be burdened with the responsibility of providing a list of unused function entry points. The point is that there's a productivity penalty associated with changing a DLL interface once you've designed it. That penalty is proportional to the number of DLLs written to the interface.

Polymorphism and Parameter Packing

A polymorphic interface, although it's admittedly cryptic, limits the cost of evolution while preserving the flexibility of dynamic linking. With some careful planning, the door to the closet of polymorphic anxieties can be kept tightly closed, even at night. Polymorphic parameters, fundamental to Windows itself, simply imply weak typing, the Wirthian anxiety.

To begin, the type of the parameter must be established and agreed on by the sending and receiving parties. The sending party must shoehorn its data into the 32-bit space by means of a compiler cast or bit-shifting sleight of hand. Similarly the receiver, collecting what seems to be an unsigned DWORD value, must prod, nudge, and dissect the value into its respective components.

Notice that the reason for creating strongly typed languages was to relieve programmers of the burden of handling this sort of data typing mentally. Conversely, notice that a great deal of excellent software predates the availability (read: preferred use) of strongly typed language

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compilers. You can certainly create robust software using polymorphic entry points, but you have to really want to. Failing to properly cast a 16-bit pointer before passing it into a 32-bit integer parameter can result in the compiler incorrectly filling the upper 16 bits of the parameter with a sign extension. Even if the receiving party is able to dereference this new and interesting data type, we can be assured that it does not point to the intended value.

If you're unfortunate enough to be implementing a DLL for which you have no knowledge of the calling application, you'll be able to get some mileage from the new parameter-validation routines that are available in the Windows 3.1 API. Such routines can be used to ensure that a pointer to writable memory is actually so. Alternately, by establishing some clever design standards for parameter passing, additional typing knowledge can be imparted on polymorphic parameters.

Notice how most of the new data structures in Windows 3.1 require that you initialize the first DWORD of the structure with the size of the structure. My guess is that this information makes implementing a thunk-layer (e.g., Windows 3.1 running on Windows NT) that much easier. The thunk can examine the first field of the structure and determine whether a 16- or 32-bit compiler created the structure. I call this approach "better than nothing" or "strong most of the time" typing.

Choosing the other alternative—separate named entry points for each function—solves these problems. Or does it solve them? Essentially, the big problem you face with polymorphic parameters is ensuring that the proper values are packed into parameters (primarily during compilation). If either side of the interface changes without both entities (application and DLL) being aware, problems at run time persist with either solution. If the application adds a new parameter to a function call and the DLL entry point is expecting the old stack frame, the system will die an ugly death.

Creating individual entry points does, of course, make for more readable code. Consider how much more cryptic the Word filters would be with a single entry point. Achieving maximum benefit from multiple entry points is a result of stabilizing the names and/or ordinal identifiers of the exported DLL functions. This allows the specification to be "grown" without affecting earlier incarnations of the DLLs.

Basically, the difference between fewer polymorphic entry points and more numerous typed entry points is the amount of information about the interface that is packaged with the DLL itself. The presence of more information means greater understandability and more opportunities for querying the DLL package (at run time) about its capabilities. Maintaining this extra information means a proliferation of module definition file entries and methods, resulting in a greater "change ripple" when parts of the interface evolve. But perhaps this required effort will shift our emphasis toward getting the interface right the first time, focusing our attention on the value of good software engineering and design. ■

Gen Kiyooka is the founder of Electron Image. He creates Windows software and is the inventor of the RoboHelp Windows help authoring tool and the BugMan debugging agent from Blue Sky Software. You can reach him on BIX c/o "editors" or on CompuServe at 76376,43.

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ASK BYTE

Time Flies

I recently had my 16-MHz 386DX chip replaced with a 20-MHz 386DX chip. Everything works fine except for the system clock. Immediately after I turn on my computer, running the DOS TIME command gives the correct time (e.g., 3:00 p.m.). Running the command a minute later gives the incorrect time of 3:02 p.m. The problem is apparently in software, because if I switch the computer off and on, the DOS TIME command again yields the correct time. What's the problem, and how can I fix it?

Samuel L. Park
Alexandria, VA

The source of your problem is hardware, not software. Your computer actually has two clocks. The battery-backed CMOS real-time clock maintains the correct time even when your system is off. The system timer controls the speed of the CPU and related peripheral chips. When you replaced the CPU with a faster chip, the technician also replaced the system-timer crystal with another, probably rated at 40 MHz. (System-timer crystal signals are divided by 2: 40 MHz/2 = 20 MHz.)

When you boot up, the BIOS reads the time from the CMOS real-time clock and stores the values in a set of memory locations that it uses as a counter. The BIOS uses the CPU system timer to update the counter 18.2 times per second and does not look at the real-time clock until you reboot the computer.

Unfortunately, your BIOS still assumes that you are running the CPU at 16 MHz, not 20 MHz, and updates the registers more quickly. Both time and your CPU run 25 percent faster.

Short of going back to a 16-MHz system clock, the only solution is to use a TSR program that looks at the real-time clock and updates the DOS time and date. One such program is ATCLOCK, available on BIX in the IBM.AT listings area. This clock device driver uses the CMOS real-time clock for all DOS timekeeping functions.

—Stan Wszola

Weather by Shortwave

In September, Ask BYTE answered a question from Pascal Gilles about receiving weather maps via shortwave radio transmissions and displaying them on his PC. Our advice was to go to a commercial service. Several readers responded that it is indeed practical to receive weather maps by shortwave radio. Here's one reader's explanation of how to do so.—Stan Wszola

I write a monthly column called RTTY: The Exciting World of Radioteletype Monitoring for *Popular Communications*. The column covers radioteletype and radiofax stations that can be heard over shortwave radio. All Gilles needs is a radiofax demodulator to connect to his computer's serial port and to the external speaker or earphone jacks on a shortwave radio, and the software to drive the interface.

Numerous weather stations on all continents, including Antarctica, use shortwave radio to send weather maps of all types, which are used by the military and maritime/aviation stations. Many weather stations broadcast 24 hours a day, including the U.S. Navy's. Gilles can easily monitor the radiofax weather station located in Rome over shortwave radio.

Companies that supply radiofax demodulators and software include Advanced Electronic Applications (P.O. Box C2160, 2006 196th St. SW, Lynwood, WA 98036, (206) 774-5554), MFJ Enterprises (P.O. Box 494, Mississippi State, MS 39762, (601) 323-5869; fax (601) 323-6551), OFS Weatherfax (6404 Lakerest Court, Raleigh, NC 27612, (919) 847-4545), Software Systems Consulting (615 South El Camino Real, San Clemente, CA 92762, (714) 498-5784; fax (714) 498-0568), and Hoka Electronics (Telko Clockstraat 31, NL-9665 BB Oude Pekela, The Netherlands).

All products require a high-quality shortwave receiver that covers the range of 2 to 30 MHz and that can receive SSB (single sideband) transmissions.

Robert Margolis
Lake Forest, IL

Loopback Tests

Can you tell me the pin configuration for the 25-pin serial and parallel loopback plugs?

Joseph A. Inguaggiato
Matawan, NJ

Most diagnostic software packages perform loopback tests on serial and parallel ports. To perform the test, you must attach a loopback or wrap plug that connects the output signal pins to the input signal pins. Running test signals through these ports is more effective than merely accessing the internal diagnostic mode of the UART (universal asynchronous receiver/transmitter) chip to see if it is active.

If you are handy with a soldering iron, the loopback plugs are easy to make. On a serial RS-232 nine-pin port, use a female DB-9 connector and connect pins 1 to 7 to 8; 2 to 3; and 4 to 6 to 9. For serial RS-232 25-pin ports, you'll need a female DB-25 connector with pins 1 to 7; 2 to 3; 4 to 5 to 8; 6 to 11 to 20 to 22; 15 to 17 to 23; and 18 to 25 connected. To test a Centronics 25-pin parallel port, you'll need to connect pins 1 to 13; 2 to 15; 10 to 16; 11 to 17; and 12 to 14 in a male DB-25 connector.

—Stan Wszola

Boot Differences

I know that resetting my computer with the Ctrl-Alt-Del keys doesn't do the same thing as turning the power off and on again, but what about using the reset button? I assume that its actions fall somewhere in between the two extremes.

Joe S. Herring
Rockport, TX

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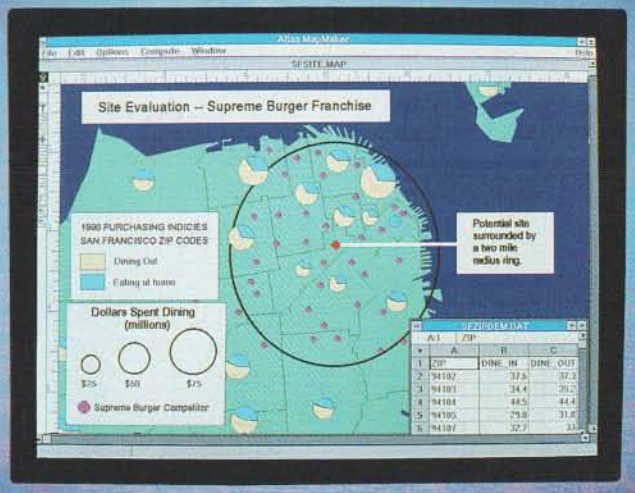

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Circle 251 on Inquiry Card

Turning the computer off and on again is referred to as a cold boot. When you turn on a computer, the inrush of power stresses the semiconductor components in the system. The Ctrl-Alt-Del combination, or "three-finger salute," is called a warm boot. It resets the system but skips the POST (power-on self test) routines and memory test.

The reset button is an intermediate way to restart the system. Technically, it's a cold boot: It clears all memory locations and performs the POST routines and memory test. It doesn't, however, cut off power to the semiconductor components. The reset button is a convenient way to restart your computer when an ill-behaved piece of software has locked up the system.—Stan Wszola

Megabyte Math

In the August Ask BYTE, Jeffrey A. Sawyer complained that his new Seagate ST1144A IDE hard drive was advertised as having a capacity of 130.7 MB but formatted to only 124.7 MB. Our response notwithstanding, there is nothing wrong with Mr. Sawyer's hard drive. As alert readers quickly pointed out, Seagate calculates 1 MB as 1 million bytes (10^6) instead of the actual 1,048,576 bytes (2^{20}) per megabyte when formatted. This effectively turns Seagate's "130.7-MB" hard drive into a 124.7-MB device.—Stan Wszola

Software Publishers and C Books

I am a software programmer trying to market a product, and I am looking for companies who will market my product and pay me on a royalty basis. CJ Software Publishing used to offer such services, but I'm unable to contact it. Has it gone out of business?

Another problem that I have is with the lack of information on C programming. Many techniques and methods are not covered in any texts I've seen. For example, how do you call another program, run it, and return back to the mother program?

Another problem is memory allocation. Every text shows you how to allocate memory for a single-dimensional array, but never for the more commonly used multidimensional array. Where can I find the answers to such questions?

Daryl F. Watson
Calgary, Alberta, Canada

I don't know what has happened to CJ Software Publishing, but other companies will help you market your product. Look in the classified sections in your favorite computer magazines under "software packaging" and "software marketing."

Many books have been written about C and C++ programming. The problem is finding the correct book. One place to start is with a programming periodical such as the C Users Journal *(R&D Publications, 1601 West 23rd St., Lawrence, KS 66046, (913) 841-1631).*

As to your programming questions, the method of accomplishing some of the tasks depends on the compiler and libraries you use and the operating system in which you're running. In the Unix environment, you usually invoke a separate program with a call to one of the family of `exec` *system function calls. The MS-DOS environment has the* `spawn` *library functions. The Macintosh environment has a process manager that can launch, track, and control other programs. Launching programs and many other tasks are system-dependent. That's why general books on programming in C don't adequately cover these issues.*

Your question concerning multidimensional arrays and memory management is of a much more general nature. When you declare a fixed-size multidimensional array, you must also specify the size of each dimension when you declare the array. (It is not necessary to specify the size of the first dimension in certain situations.) As an example, a list of words might be defined as `char wordlist [80][80];`.

But if you plan on allocating the memory dynamically, as needed within a function, you will need more sophisticated operations. You will want your array to act as a contiguous block, but separate calls to memory allocation functions don't ensure that this will happen. Therefore, you must either create your own structure of block lists or use a heap management library such as Rick Grehan's routines in "If Memory Serves..." (August 1989 BYTE). As you are aware, dynamic arrays are not a trivial problem.—Ben Smith

Keyboard Guardrails

I'm a careless typist. Sometimes I accidentally hit two keys at once, or my finger slides off the edge of one key onto the next. Why can't someone make guardrails between the keys to prevent this? Can you picture a sort of grillwork level with the top of the key to protect the *i* when I almost missed the *o*? Has anyone ever made such a keyboard, or could a manufacturer produce such a grillwork that could simply be laid over a standard keyboard to help me avoid these silly errors?

Sam I. Lerman
Southfield, MI

You can get such devices for most computer keyboards through a distributor of occupational-therapy equipment such as Enrichments (P.O. Box 579, Hinsdale, IL 60521, (800) 323-5547 or (708) 325-1700). Readers outside the U.S. should ask for Joanne Dorris.

BYTE testing editor Howard Eglowstein has written a one-key rollover (i.e., the number of keystrokes made active at a time) keyboard driver for MS-DOS. If you use this as your interface to your PC, you can limit the rollover to one and prevent the double letters that often result from pressing more than one key at a time. You can find similar programs in many keyboard utility packages. Eglowstein's version, called rollover.com, is available on BIX in the FROMBYTE92 listings area.

—Ben Smith and Howard Eglowstein ■

The BYTE Lab welcomes your questions. Address correspondence to Ask BYTE, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send BIX mail c/o "editors."

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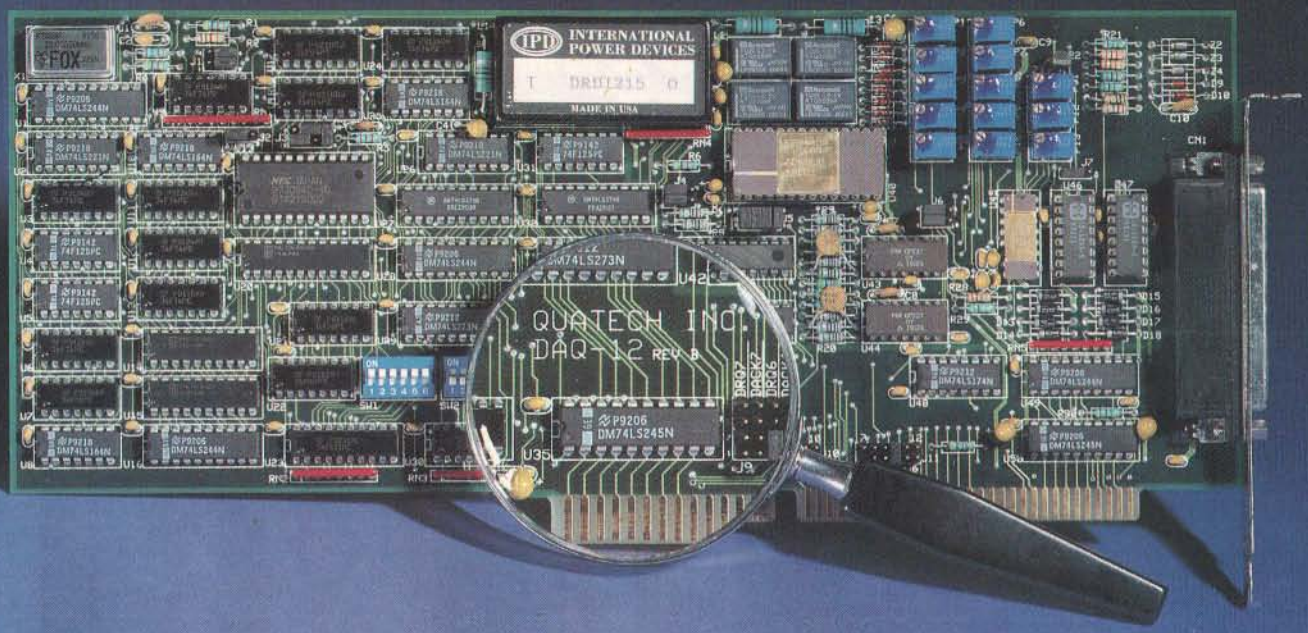

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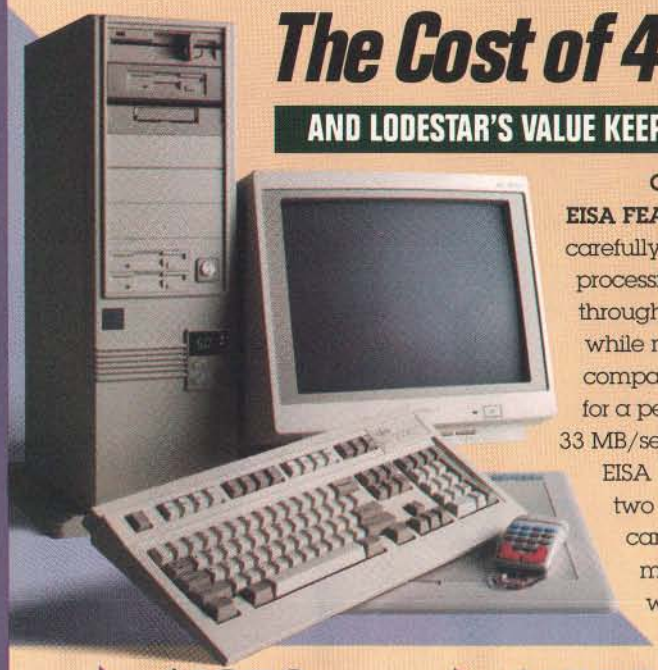

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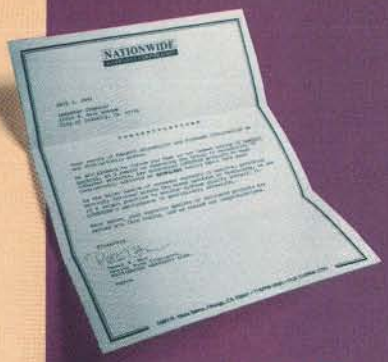

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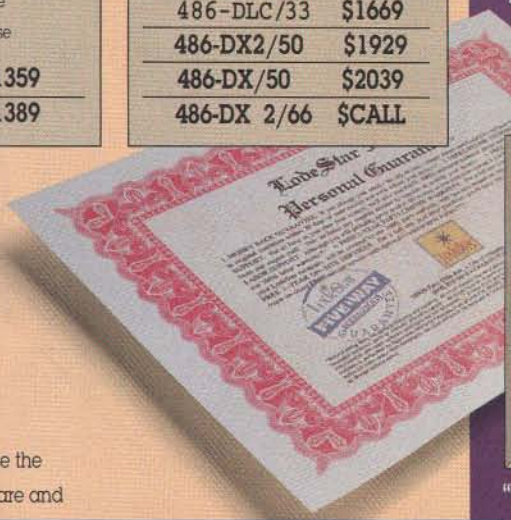

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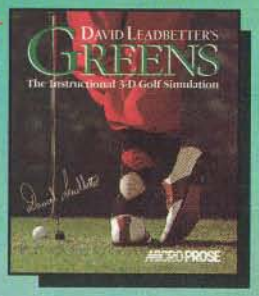

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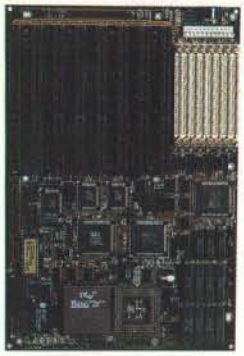

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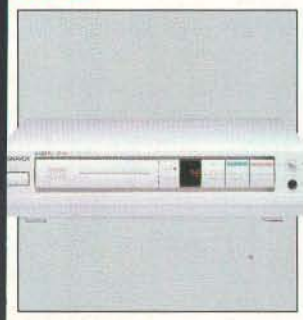

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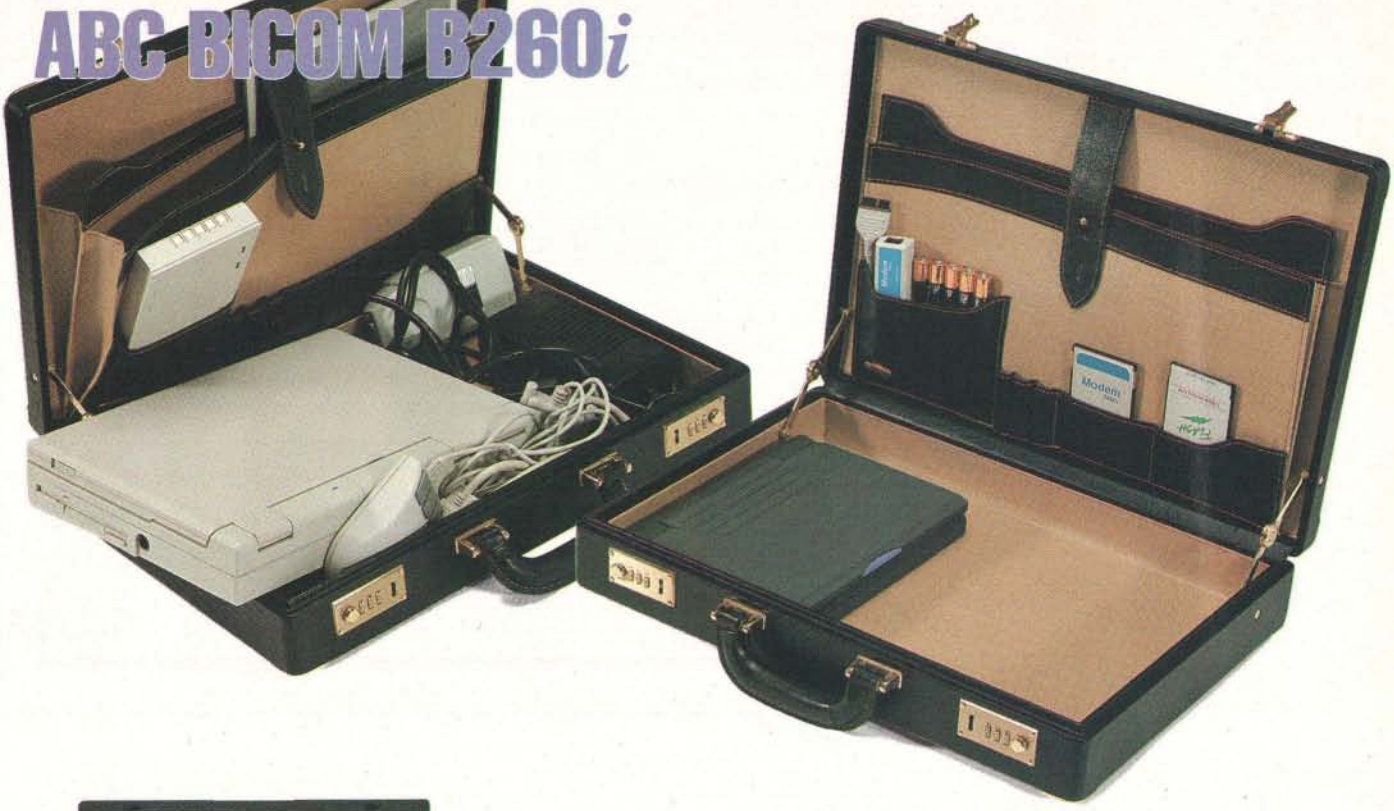

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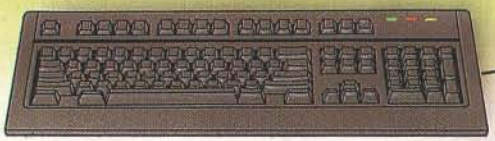

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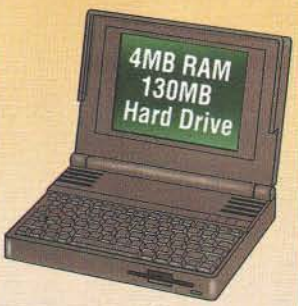

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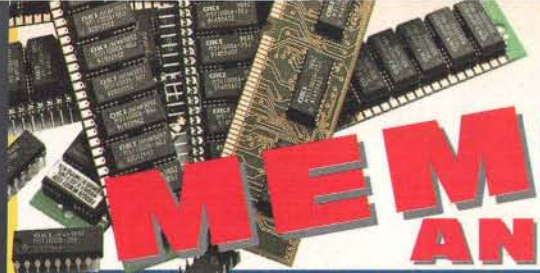

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PS/1 286, 386SX
2MB 92F9935 ..... $99
PS/2 30/286, Expansion board 1497259
2MB Kit 30F5360 ..... $89
PS/2 35SX; LS, 40SX, 50Z, 55SX; LS, 65SX; LS, 70 & XStation
1MB 6450603 ..... $49 2MB 6450604 ..... $79
PS/2 70-A21; A61; B21; B61
2MB 6450608 ..... $79
PS/2 35SX; LS, 40SX, 55SX; LS, 65SX; LS, 34F50XX & XStation
4MB 34F2933 or 87F9977 ..... $135
PS/2 35SX; LS, 40SX
8MB 6450129 ..... $289
PS/2 90, 95, and P75 (Install in pairs)
4MB 6450128 ..... $135 8MB 6450130 ..... $289
Expansion boards for 50, 50Z, 55SX, 60, 65SX
2-8MB with 2MB 1497259 ..... $269
2-16MB with 2MB 6450609 ..... $309
Expansion boards for all models 70 and 80
2-14MB with 2MB 34F5077 ..... $329

Compaq

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ProLinea 3/25; 3/25zs
2MB 141758-001 .... $90 8MB 141742-001 ... $285
DeskPro 386-20, 20E and 25
4MB Module 113132-001 ..... $159
4MB Board 113645-001 ..... $219
DeskPro 386S/16
4MB Module 112534-001 ..... $159
4MB Board 113634-001 ..... $229
DeskPro 286N, 386N; I Series; 386SX/20, 20N; Portable 486c; M Series expansion boards; SystemPro LT Series
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4MB 118690-001 ... $135 8MB 112877-001 ... $299
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2MB Kit Z-605-1 ..... $99
Zenith 486/33ET; 25E
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2MB D2406A ..... $99 8MB D2404A $319
Vectra 486 PC (Install in pairs)
4MB D2151A ..... $169 8MB D2152A ... $349
Vectra 386/25, 486/25T, 33T (Install in pairs)
2MB D2581A $99

NEC

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2MB Kit OP-410-8103 ..... $99
Powermate 386/20; 25
2MB APC-H655 ..... $329 8MB APC-H656 ..... $659
Powermate 386/33E and 486/25E
2MB OP-410-5101 ..... $199

AST

Bravo 386-SX, WS/286, 386
2MB 500510-002 ... $89 4MB 500510-008 .. $179
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1MB w/WPB 500780-003; 002 ..... $59
Bravo 4/33; 486/25; Premium II; TE; Server SE 4/33
2MB w/WPB 500718-004; 780-005 ..... $119
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- ✔ Compaq Portable III and DeskPro 286
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- ✔ IBM PS/2 25/286, 30286, 50, 50Z, & 60
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212N and 320N Laptop NEW 1MB $89
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Everex

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IBM

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L40SX and N33SX Laptop 4MB $135
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UltraLite SL/20, SL/20P 2MB $149
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ProSpeed 386 2MB $149
8MB $449

Texas Instruments

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Toshiba

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4MB $169
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T3300SL Notebook 2MB $139
4MB $189
T4400 and T6400, SX, SXC Notebook 2MB $139
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Zenith

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1MB C2063A ..... $49 4MB C2065A $149
Hewlett Packard DeskJet 500, 500C
256K 22707B $59
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Canon LBP-4
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Grumman Aerospace

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-Joseph Rondini
New Milford, Connecticut

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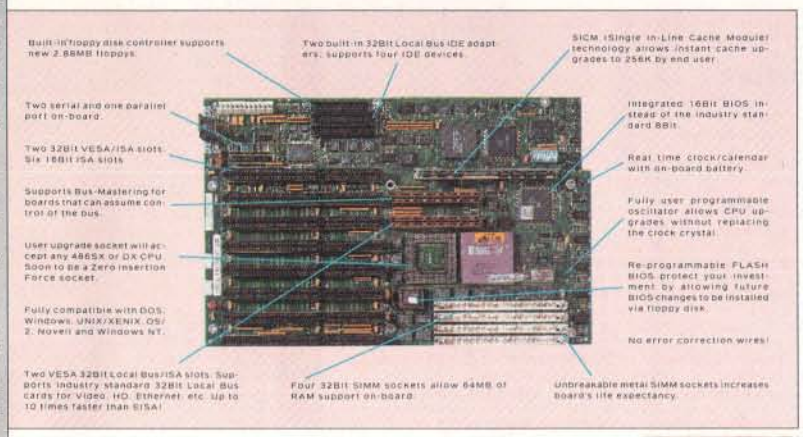
-Ronald O. Koski
Adrian, Michigan

HEART

Many will follow a familiar path, others feel compelled to set their own distinct course. Those who choose ARES place themselves firmly in the second category. The new ARES VL-Bus motherboard represents a new beginning in PC performance by incorporating the compatibility of the VESA (Video Electronics Standards Association) Local Bus along with the unprecedented power of the Intel 80486 line of processors. Our steadfast goal is to make you an ARES customer for life by offering you guarantees and support policies that our competitors dare not match. ARES takes the time to do things right...recognized throughout the industry for our many design accomplishments, such as:



A 72 hour burn-in, followed by a rigorous 4-hour 100-point quality certification test, documented by a personalized 4-5 page printed report signed by a skilled ARES Technician.

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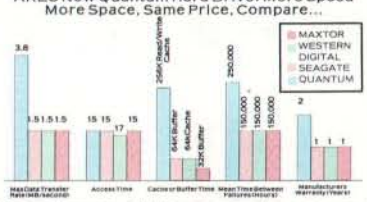
Innovative Motherboards, Award Winning Video Cards, Superior Hard Drives... Uniquely Combined To Carry On The ARES Trademark Of Excellence.

It's The HEART Of ARES

BODY

With greatness of heart comes strength of body. And our strength lies in the multitude of ARES systems owners who express their enthusiasm and appreciation to us every day in customer satisfaction letters, follow-up calls, and on PRODIGY.

ARES New Quantum Hard Drive: More Speed More Space, Same Price, Compare...



A personal computer company should do many things...it should inspire confidence and a sense of freedom. It should have a reputation that earns respect. It should, from day one, provide exactly what you need - both hardware and applications solutions. And do so without costly "free" software that you'll never use. It should offer a boundless horizon with the flexibility to grow and expand in limitless directions. THIS *IS* ARES! If you're looking for everything a personal computer should be, there is only one choice... ...AND ARES WAS THE CHOICE OF:

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- TWA
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- NASA
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intel inside

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It's The BODY Of ARES

ARES MICRODEVELOPMENT, INC

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The soul of an ARES is found in the people that stand behind it. Our standards are the same as yours: quality first. Our technology may be envied and emulated throughout the industry, but our people, proud and dedicated, are our greatest asset.

Our objective is customer satisfaction. We begin with the highest quality product, and couple it with unparalleled service. We build a reliable product with dependable and responsive people to back it up. From the onset of design to the final process of packaging and delivery, quality is paramount.

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3 Year Free Parts Warranty	●			
Lifetime Limited Warranty	●			
Free 1st Year On-Site Service	●		●	●
2nd Yr On-Site Service Contract Offered	●			
Upgradeable MotherBoard	●	●		
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Your choice of ARES Platinum Series Keyboards
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486-50EISA

A Same configuration as above.

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4MB RAM expandable to 64MB on board
Quantum 170MB IDE Hard Drive or Maxtor 213MB IDE Hard Drive
Teac 1.44 and 1.2 MB Floppy Drives
Viewsonic 6e SVGA Non-Interlaced Monitor w/.28Dot Pitch
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$2,495.00 $2,595.00

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-Rebecca Rohan
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I called 11 different companies to research my purchase. The ARES sales rep. was by far the most knowledgeable and courteous. He got my order.

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U.S. Embassy, Madrid

ARES sold me the first time on system quality and performance; but more importantly, I was sold the second time on customer support.

-John M. Messineo
Tampa Florida

I purchased an ARES because they are truly a people company. They made me feel that I was the most important customer to them.

-Carol Green
New York, New York

In short, ARES just reeked of quality throughout, from the sales rep. to the follow up letters, to the system itself and the documentation. I am very pleased with ARES.

-Prof. Jim Wade
Germantown, Pennsylvania

The 486-33 Sonic is an outstanding buy - and more so because of the company that stands behind it.

-Russ Lockwood
PC World

You can return the unit within 60 days if you are still not satisfied, but with service this good, it's not likely that you will need to do this.

-William Bettini
PC Magazine

ARES has assembled an organization to be proud of and equipment that compares most favorably with any that I have been exposed to (I have worked with both Dell and IBM).

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Many manufacturers would require you to use 10.5" of height for a PC, 14" for a monitor, and 3.5" for a keyboard drawer (on which you are supposed to balance the keyboard while you type.) This comes to 28" (16 rack units) of rack height. Our new VRK models include all of these components in just 10.5" (6 rack spaces) tall. You can fit 2⅔ PC's in the space of their system, or simply have a rack-mount PC where it was never possible before.

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- Hold-Down keeps Expansion Cards Firmly Seated.
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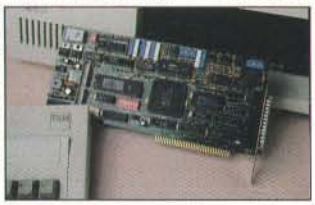
Circle 392 on Inquiry Card.

Keithley Metrabyte Sets the Standard — AGAIN



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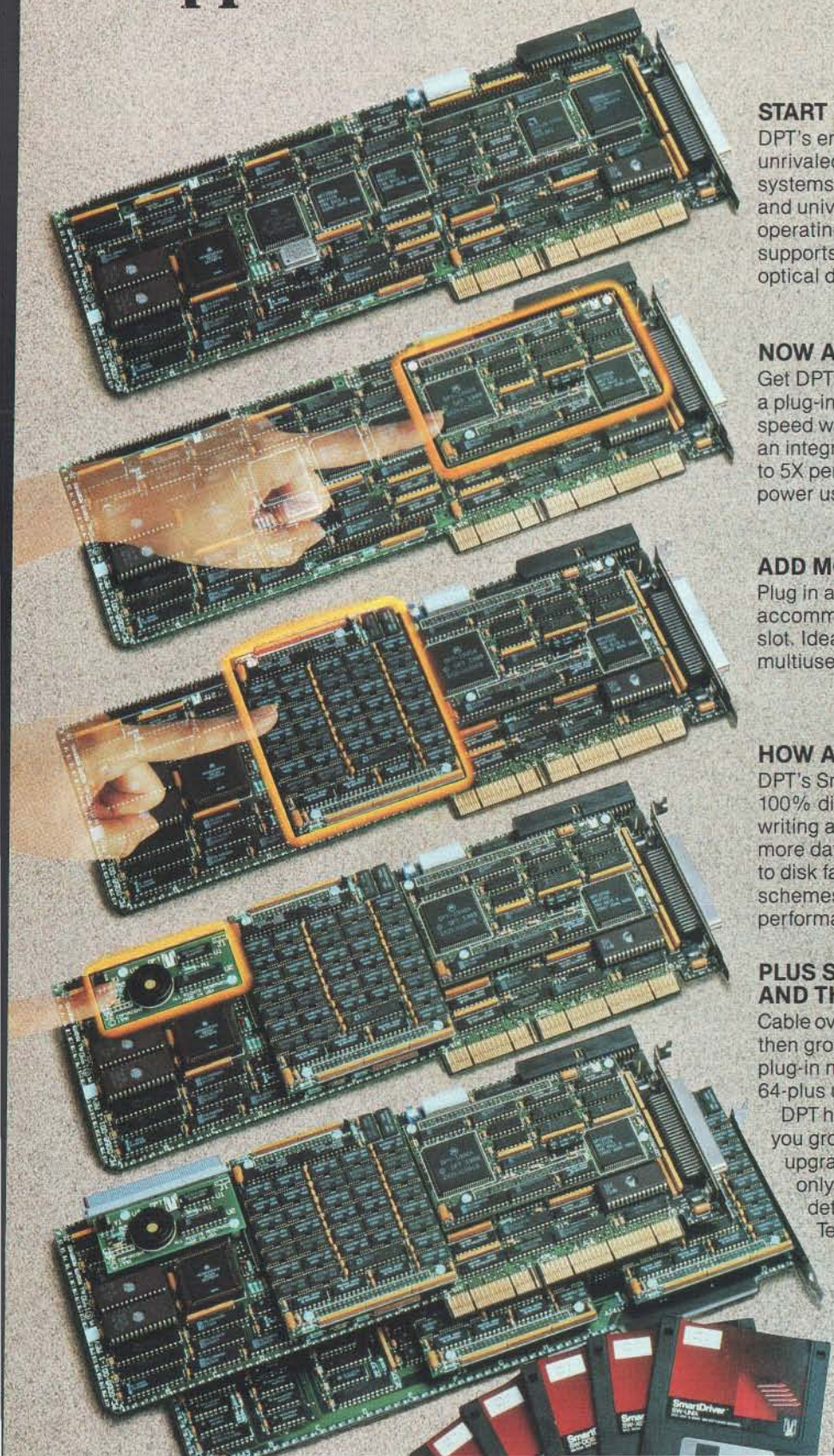

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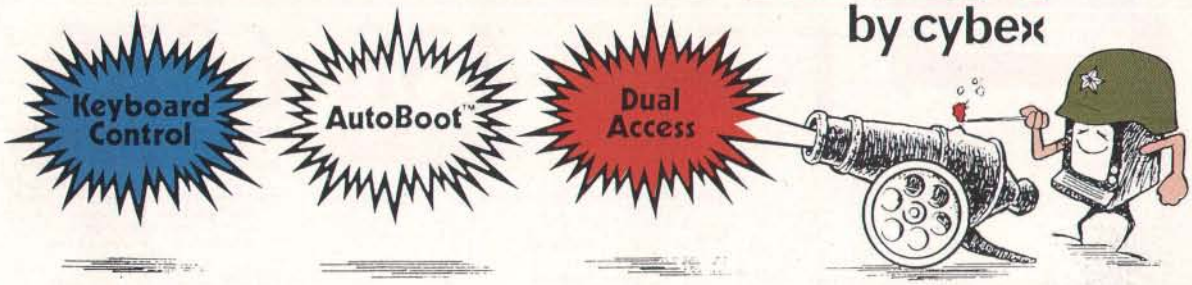
Circle 194 on Inquiry Card.

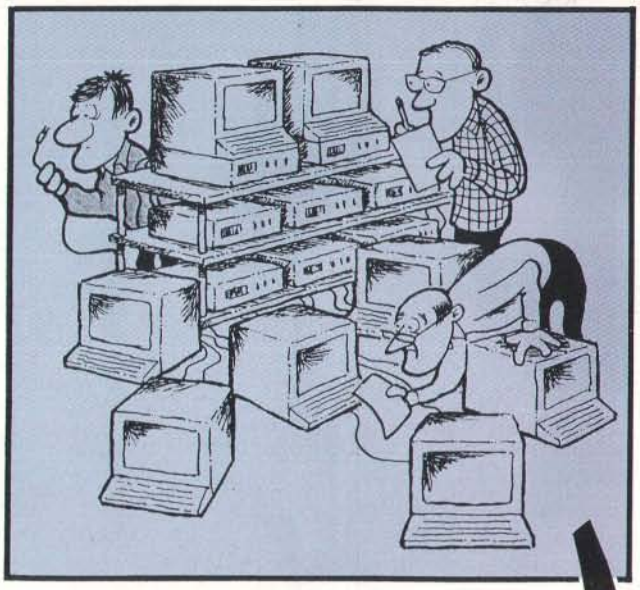
CONTROL UP TO 96 PC FILE SERVERS WITH 1 KEYBOARD AND MONITOR USING...

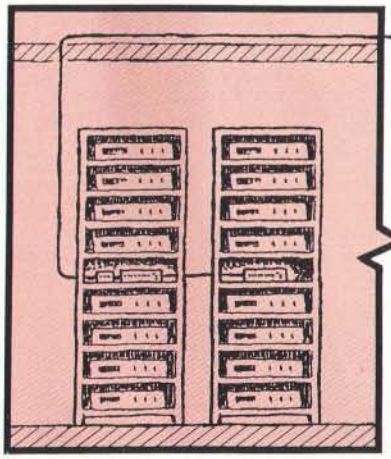
COMMANDER

by cybex

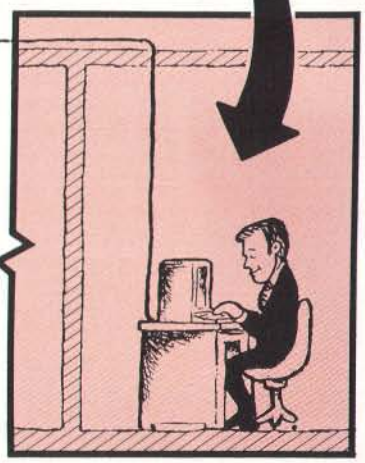


- Select via Keyboard
- Dual access up to 250 feet away (optional)
- No external power
- Mix PC, PC/XT, PC/AT and PS/2
- "AutoBoot™" Feature boots attached computers without operator intervention
- Shows PC power status





- PS/2 Mouse support available
- Each unit accommodates from 2 to 8 PCs
- Up to 12 units can be cascaded
- Mounting kit available for 19" and 24" rack installation



Dealer Program Available

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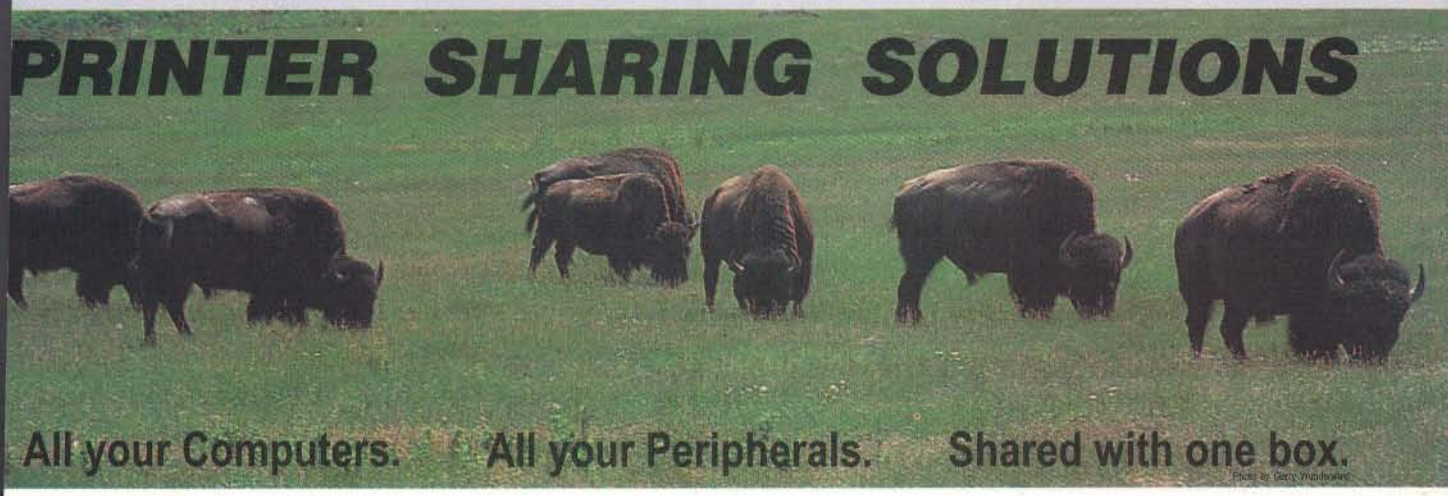
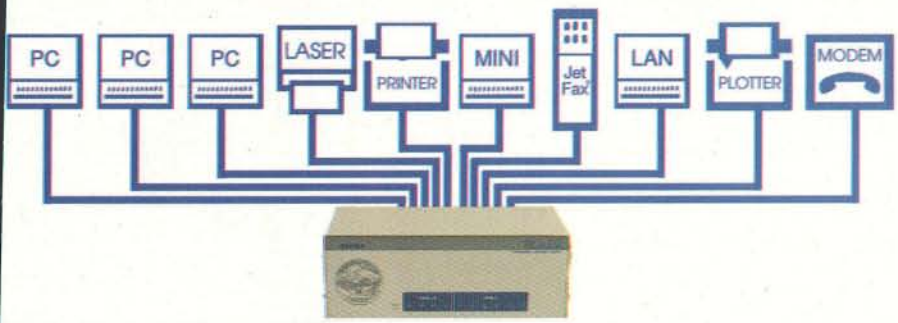
Circle 196 on Inquiry Card (RESELLERS: 197).

BUFFALO®

PRINTER SHARING SOLUTIONS





Buffalo SL Series Features:

• Two Models:
SLmkII - 4 parallel and 6 serial ports.
SLP - 8 parallel and 2 serial ports.

• Flexible Configuration:
Any port of your SL Series box may be set as either input or output.

• Rapid Data Transfer:
The SL Series software allows PCs to transmit up to 8,000 characters per second parallel and up to 115,200 bits per second serial, much faster than the DOS serial limit.

• Automatic Switching:
SL Series Buffalo boxes will automatically buffer data, convert between parallel and serial, and route data from your PC to the device of your choice. No commands are needed when sharing only one printer.

• User Upgradable Memory:
SL units are available with installed buffer memory from 256KB to 4MB. Buffer modules can be added later to expand any unit to the full 4MB.

• Easy Installation & Use:
Connect one cable for each PC or output device to the SL Series box. Run the SETUP program to configure the Buffalo box and to install the pop-up menu. Then, simply select your printer and print as you did before you installed the box.

• Pop-up Menu Option:
Select printers, macros, and other control functions using the cursor or a mouse. The pop-up menu appears over other applications and desktop publishing.

• Network Server Support:
Connected to a network server port, the SL Series can direct data to a variety of shared output devices.

• Windows Support:
Buffalo hardware and menu software are Windows compatible.

• Toll-Free Technical Support:
Skilled technicians will answer your call and help you achieve the best performance from your system.

• Cost-Effective Solutions:
Prices for the SLmkII and the SLP range from just $595 with 256KB of memory to $995 with a full 4MB installed.

• Smaller Alternatives:
The Buffalo H Series is also available priced from $245 for the HXP with 4 parallel ports and 256KB of buffer. The H Series buffers offer expandability to 16MB of buffer and parallel data transfer at up to 180,000 characters per second.

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Circle 193 on Inquiry Card.

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- 64K Super Fast Write-Back Cache SRAM
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- 1.2MB 5.25" & 1.44MB 3.5" Floppy Drives
- 32-Bit EISA Hard Disk Controller (350% faster DTR)
- 130 MB 15ms IDE Drive with 64K Cache
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- 14" Non-Interlaced .28mm SVGA Color Monitor
- 2 Serial, 1 Parallel, & 1 Game Ports
- Enhanced 101-Key Keyboard
- Hi-Resolution 400DPI Serial Mouse
- Microsoft DOS 5.0 & Windows 3.1

486/33 DX $2095
486/50 DX2 $2245
486/50 DX $2345
486/66 DX2 $2545

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- 15" Flat Screen 1280x1024 Monitor Add $190

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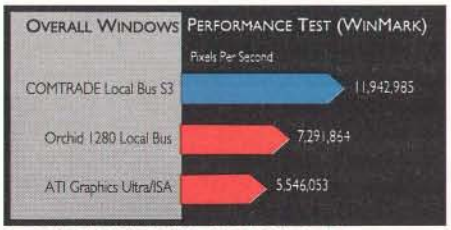

Source: COMPUTER SHOPPER, July 1992, Local Bus Video Review, Page 184.

intel inside

Circle 213 on Inquiry Card (RESELLERS: 214).

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- 15" Flat Screen 1280x1024 SVGA Color Moni
- 2 Serial, 1 Parallel, & 1 Game Ports
- Enhanced 101-Key Keyboard
- Hi-Resolution 400DPI Serial Mouse
- Microsoft DOS 5.0 & Windows 3.1

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- 130MB 15ms IDE Drive with 64K Cache
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- Enhanced 101-Key Keyboard
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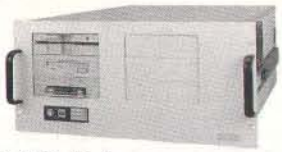

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4/75; 4/330;4/370, 4/390	16MB KIT	X116H,Y,WD	$599
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Portable 386	4MB EXP	107653-001	$449
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Deskpro 386/16	2MB	108069W71	$348
Deskpro 386/16	1MB	108071-001	$98
Deskpro 386/16	4-8MB	108070-001	$469
Deskpro 386/16	4MB	108072-001	$249
Deskpro 286E; 386-20; 20E; 25; 25E	1MB	113131-001	$59
Deskpro 286E; 386-20; 20E; 25; 25E	4MB	113132-001	$158
Deskpro 386S	4MB Board	113634-001	$218
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Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M , Systempro LT Series 129160-001	1MB	118688-001	$49
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Compaq SLT/286	1MEG MOD	110235-001	$99
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T2000SX/T1000 LE	4MB CARD	PA8314U	$168
T2000SX/T1000 LE	8MB CARD	PA8315U	$298
T1200 XE	2MB BRD	PA8306U	$92
TI600	2MB BRD	PA8302U	$78
T2000 SXE/T2100SX	2MB CARD	PA2000U	$89
T2200SXE/T2300SX	4MB CARD	PA2001U	$168
T2200SXE/T2200SX	8MB CARD	PA2002U	$328
T3100 E	2MB MOD	PA8341U	$88
T3100 SX	2MB BRD	PA8308U	$88
T3100 SX	4MB BRD	PA8310U	$138
T3200 SX	2MB MOD	PA8307U	$88
T3200 SX	4MB MOD	PA8309U	$138
T3200 SXC	2MB MOD	PA8318U	$88
T3200 SXC	4MB MOD	PA8319U	$148
T3200	3MB BRD	PA7137U	$148
T3300 SL	2MB CRD	PA2006U	$118
T3300 SL	4MB CRD	PA2007U	$148
T3300 SL	6MB CRD	PA2008U	$235
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Bondwell B-310	1MB	23050-09100	$108
Commodore	2MB	390850-01	$87
Dell 316, 320LT	2MB		$98
Dell NL20 & NL25	2MB	310-3213	$149
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Everex Carrier	2MB	00263-00	$114
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Grid 1450SX	2MB	6200203	$209
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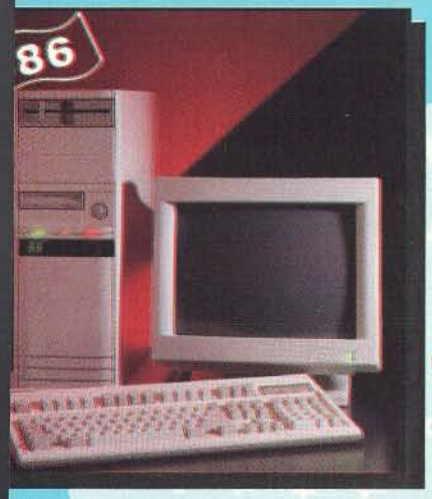

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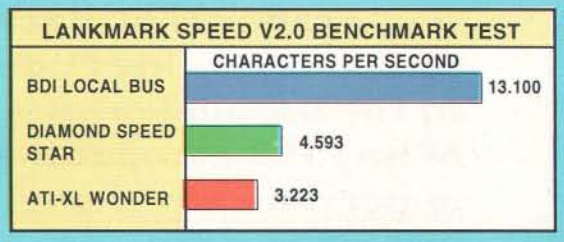

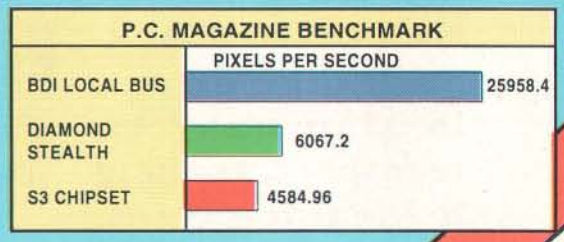

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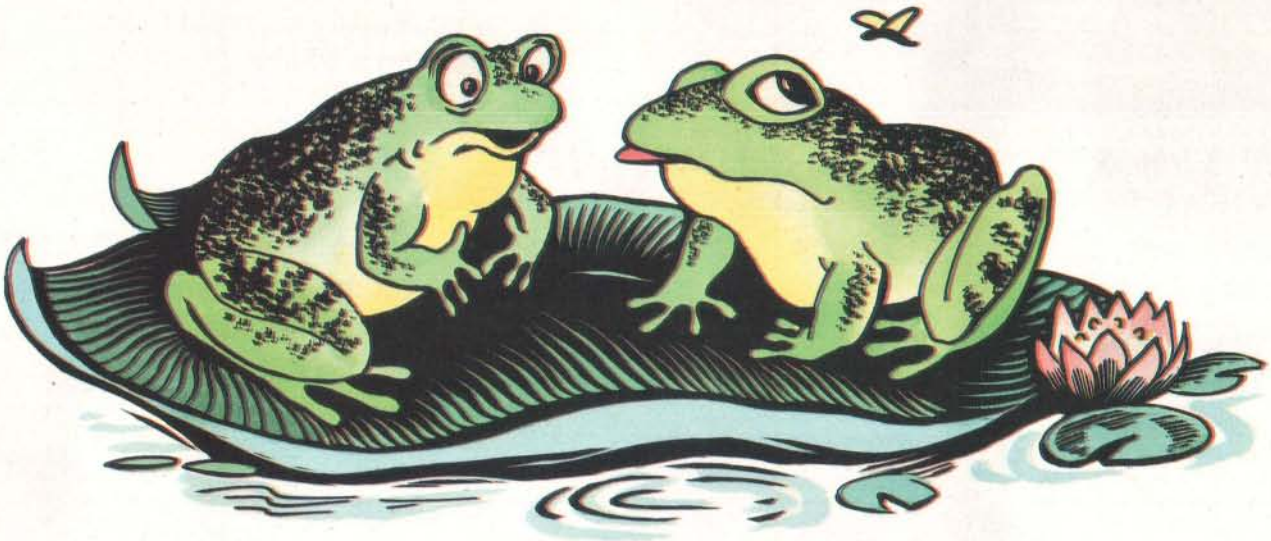

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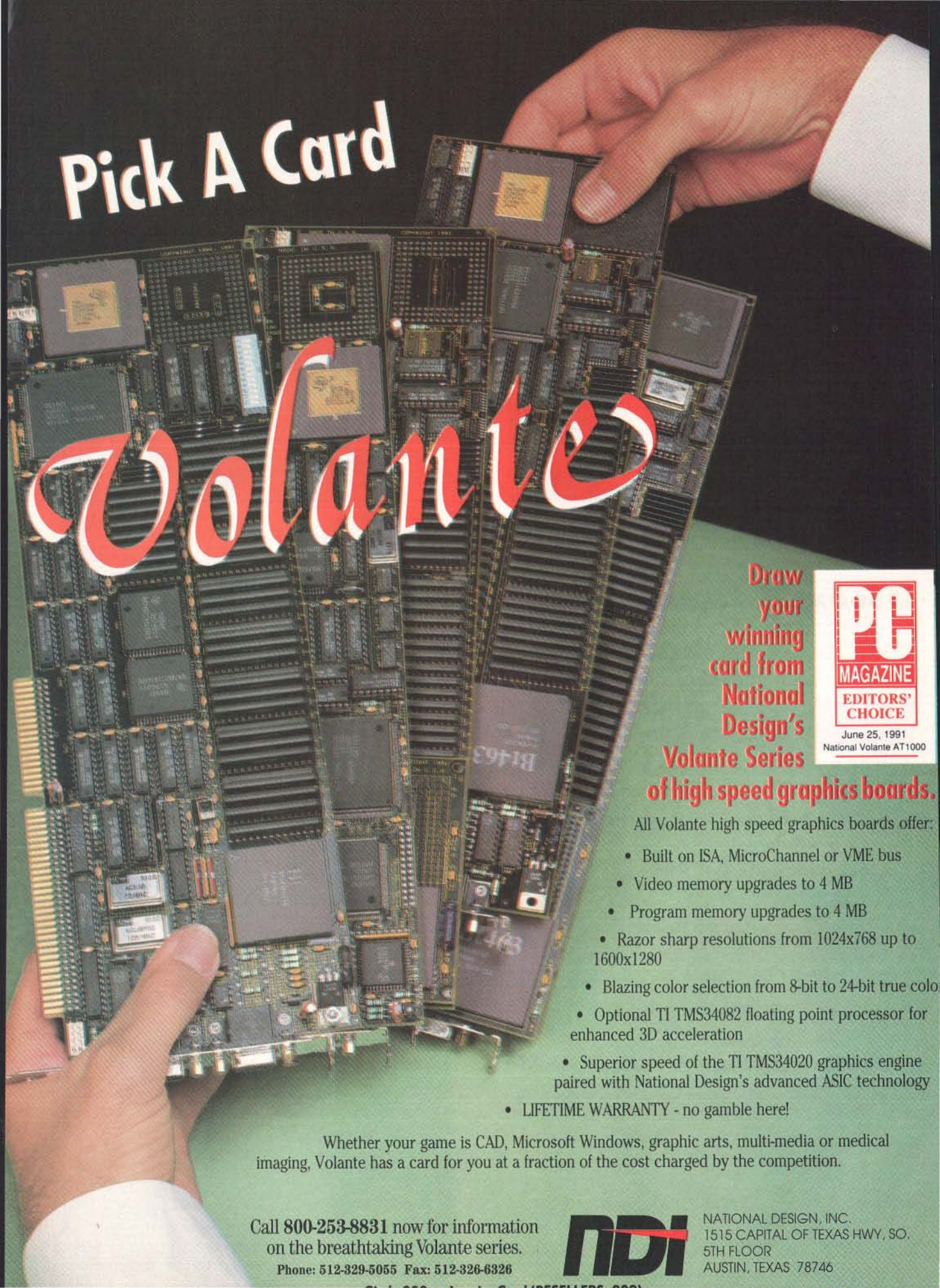
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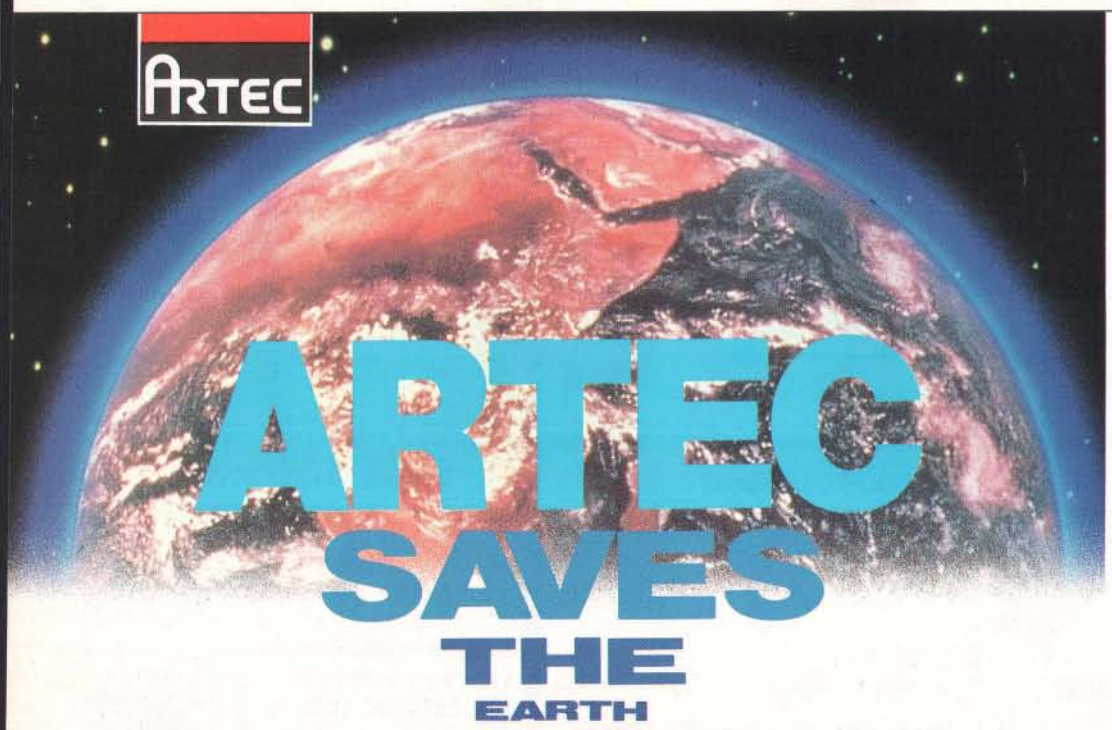

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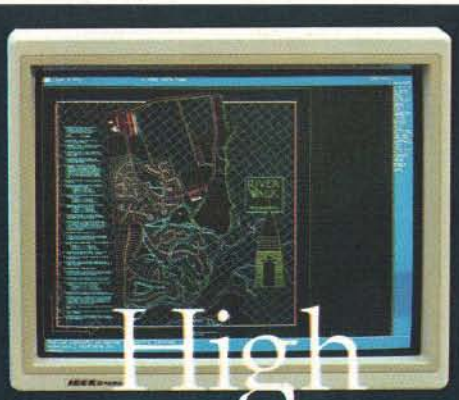

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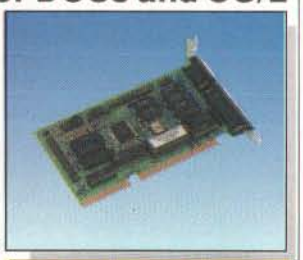

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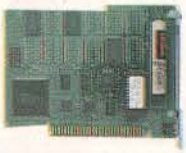

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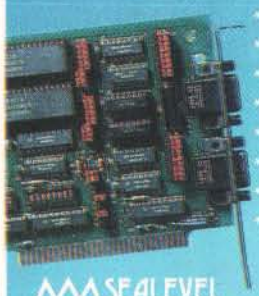

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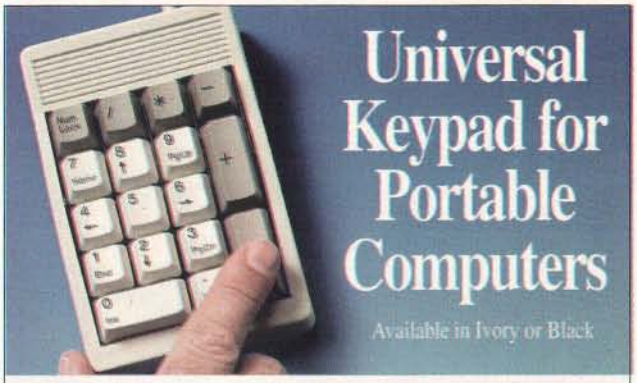

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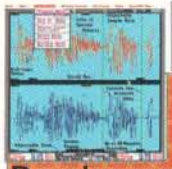

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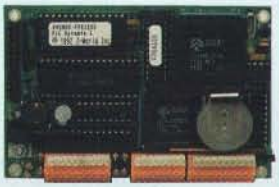

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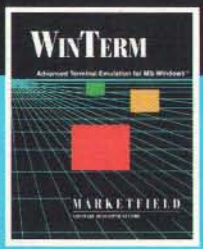

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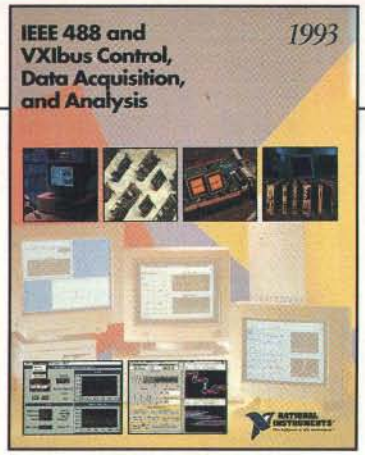

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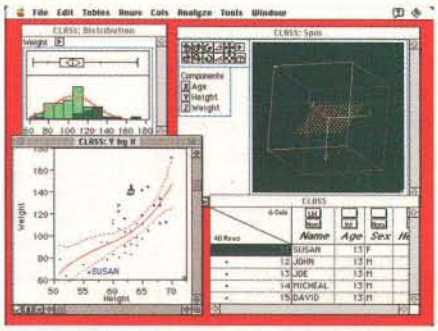

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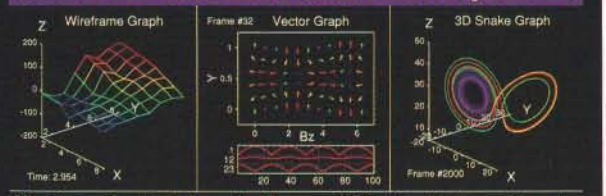

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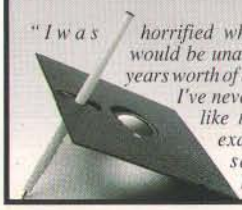

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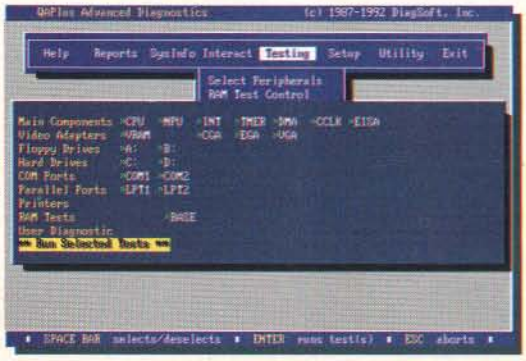

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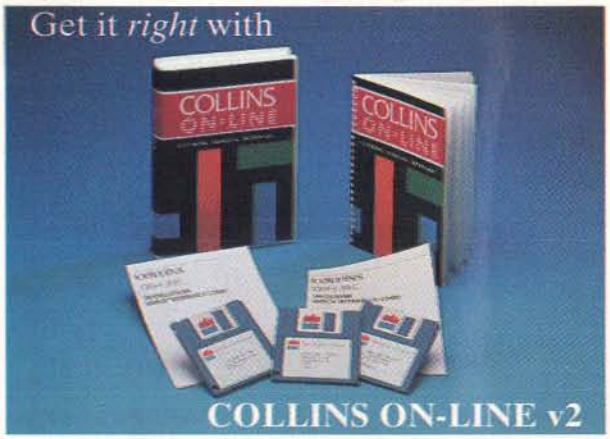

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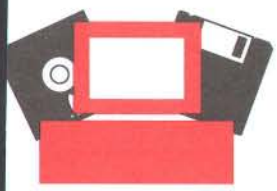

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Title

Company

Address

City Country Code

Phone Fax

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2 ❑ Programmer/Systems Analyst
3 ❑ Adminstration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?

7 ❑ Senior-level 9 ❑ Professional
8 ❑ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ❑ Yes 11 ❑ No

D. What operating systems are you currently using? (Check all that apply)

12 ❑ PC/MS-DOS 15 ❑ Unix
13 ❑ DOS + Windows 16 ❑ MacOS
14 ❑ OS/2 17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?

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December 1992 90 96 99

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1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478

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For free product information, mail your completed card today. For quicker response, fax to 1-413-637-4343!

See reverse side for card.

1. Circle the Numbers on Your Direct Link Card

Circle the numbers which are found on ads and articles in this issue or circle the product category number and receive information on all advertisers listed in that category.

2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!

BYTE

TNT MAILFAST
FRG/BOS/700252/MO1
P.O. Box 66
Hounslow
TW5 9RT
England

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2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!

Yes, I want FREE information on the following products!

Fill out this coupon carefully. *Please Print.*

Name

Title

Company

Address

City Country Code

Phone Fax

A. What is your primary job function/principal area of responsibility? (Check one)

1 ❑ MIS/DIP
2 ❑ Programmer/Systems Analyst
3 ❑ Adminstration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?

7 ❑ Senior-level 9 ❑ Professional
8 ❑ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ❑ Yes 11 ❑ No

D. What operating systems are you currently using? (Check all that apply)

12 ❑ PC/MS-DOS 15 ❑ Unix
13 ❑ DOS + Windows 16 ❑ MacOS
14 ❑ OS/2 17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?

18 ❑ 1-25 20 ❑ 51-99
19 ❑ 26-50 21 ❑ 100 or more

December 1992 90 96 99

Product Category Information

Circle the numbers below for information on the entire category of products you're interested in.

Hardware

Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24

Software

Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
Programming Languages/ Tools	40
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing	48

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Recruitment	50
Miscellaneous	51

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53	79	105	131	157	183	209
54	80	106	132	158	184	210
55	81	107	133	159	185	211
56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
76	102	128	154	180	206	232
77	103	129	155	181	207	233

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

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234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
257	282	307	332	357	382	407

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591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478

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PRODUCT CATEGORY INDEX

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on your Direct Link Card!

To receive information for an entire product category, circle the category number on your Direct Link Card!

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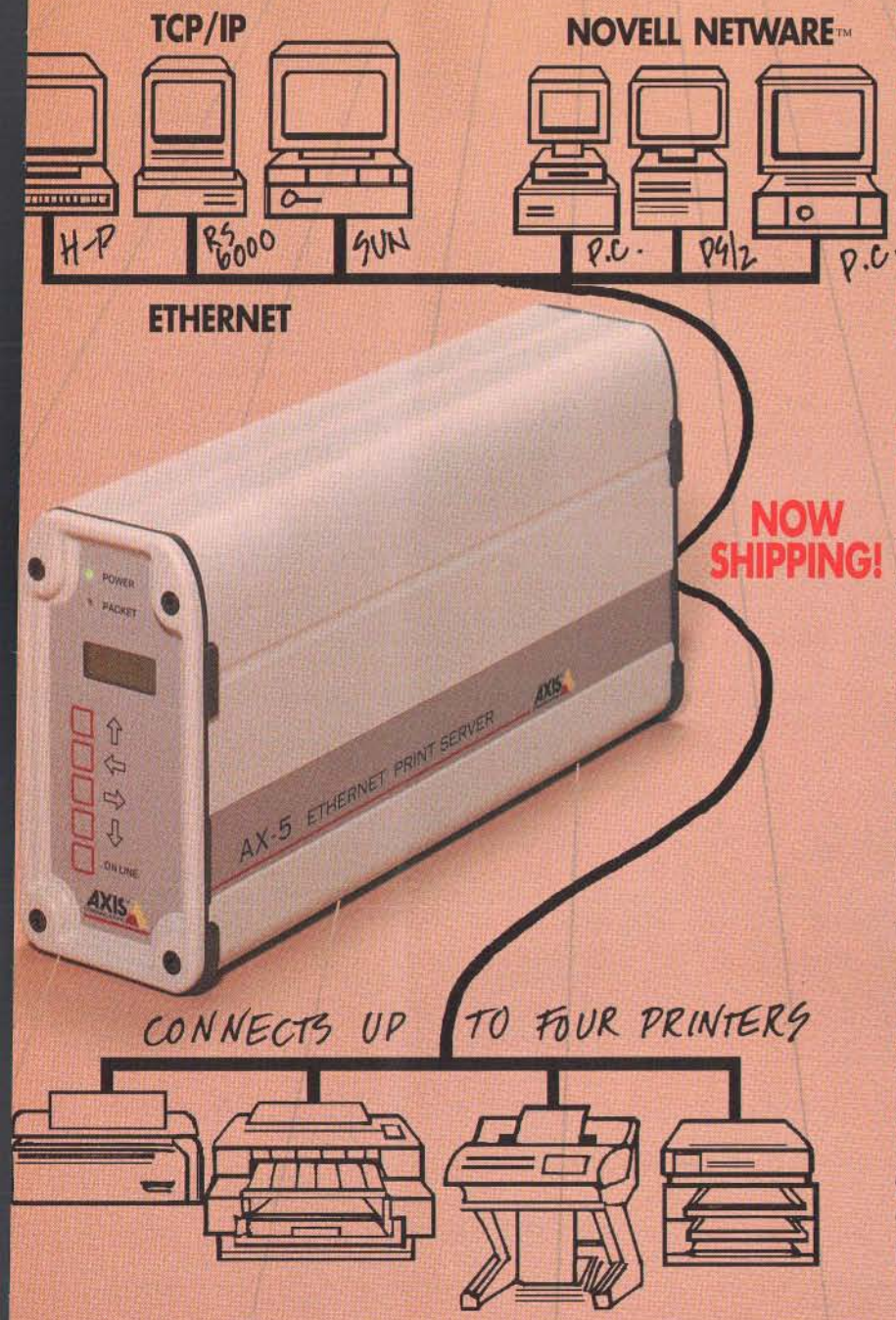

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JAMES BURKE

TECHNOLOGY AND THE NEW WORLD ORDER

One of today's greatest and most enduring myths is that telecommunications and data processing have made this a shrinking world. In our lifetime, we expect to see a Europe stretching from the Urals to the Atlantic and a North American free-trade zone ranging from Hudson Bay to the Guatemalan border. Togetherness is the flavor of the millennium. It is beginning to be politically incorrect even to mention difference.

Technological advances are increasing our social complexity

And yet, the more information technology and telecommunications bump us against each other, the more we see how different we are. When an Italian waves *good-bye*, he or she means *come here*. The Greeks nod *no*. Angle of bow is critical in Japan. You can't express the conditional in Chinese. And there are differences in the way people everywhere do business.

The more technology opens up the planet, the more it becomes clear that you can't be given this new world in an entire lifetime, never mind 30 minutes.

The technology isn't bringing us all together; it's forcing us all apart. Politically, people are breaking loose from the old, centralized, monolithic way of doing things. We had a word for it in the last century, when the Austro-Hungarian Empire broke down: *Balkanization*. Ironically, the word has come back to haunt us in today's ex-Yugoslavia. And it's also happening in Scotland, Quebec, Nagaland, Azerbaijan, Georgia, Czechoslovakia, and too many other places to name.

This fragmentation is not only political. Minority groups everywhere are staking claim to their cultural heritage and their patch of territory. Corporations are restructuring decision-making processes to make them more distributed, less hierarchical. The workplace itself is fragmenting. In the 1940s, there were 80 kinds of jobs; today there are 800. More and more people are quitting the downtown office-block life in favor of telecommuting. Citizens are less satisfied than ever with the unrepresentative nature of our representative democracies.

As the comfortable certainties of the Cold War recede, is the place falling apart? No. We're seeing the first flowers of the information age. As the networks expand and become transparent and open, as software takes the gobbledygook out of the system, making it easy for ordinary people to operate, the technology is driving a trend toward increasing social complexity.

Throughout history, radical improvements in the ability to generate and share information have always triggered information surge, which has in turn always generated bursts of innovation that brought into existence new entities, new kinds of people, new ways to live. The present information surge is no exception. It's just immeasurably more complex than anything that went before.

And complexity, ecological as well as human, makes life safer. The more heterogeneous an ecosystem, the more novelty it generates. In nature, where novelty is expressed in the variety of species, complexity enhances the likelihood of a species' survival in the event of radical environmental change.

The same process operates to protect human society. Information surge makes it possible to bring more ideas together in novel ways. When that happens, the result is always more than the sum of the parts. An example from history: gasoline + perfume spray = carburetor.

The complexifying of knowledge (from a couple of sciences 500 years ago to 20,000 specialist disciplines today) has enhanced our chances of survival and is responsible for generating the information technology that will take us to the next stage in our social evolution.

Information technology will offer the individual and the small community an unparalleled opportunity to survive as a viable entity, unconstrained by the rules and standards established in simpler times with simpler technologies, when nation states enforced conformity on communities as divergent as Scots and Maoris, when literacy was the only test of intelligence, when the political majority ruled unquestioned.

The new technology will shatter the mold. It will give us the means to tap the extraordinarily diverse talents of those billions of brains from thousands of cultures around the planet that up to now have been suppressed or ignored because we lacked the tools to manage anything but the lowest level of social complexity. And idiosyncratic, small-scale independence will benefit from other technologies, like renewable energy systems and genetic engineering.

But this Baskin-Robbins world will happen only if we bury the myth that it's good for us all to be the same. It's not. Survival and fulfillment are the products of diversity. ■

James Burke is a writer, producer, and host of BBC TV series such as Connections *and* The Day the Universe Changed. *He is working on a 20-part series on the interactive nature of knowledge for the Discovery Channel. You can reach him on BIX c/o "editors."*

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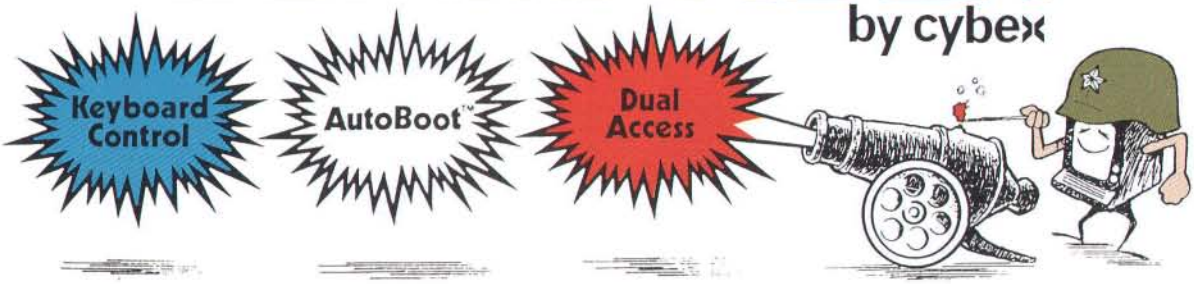

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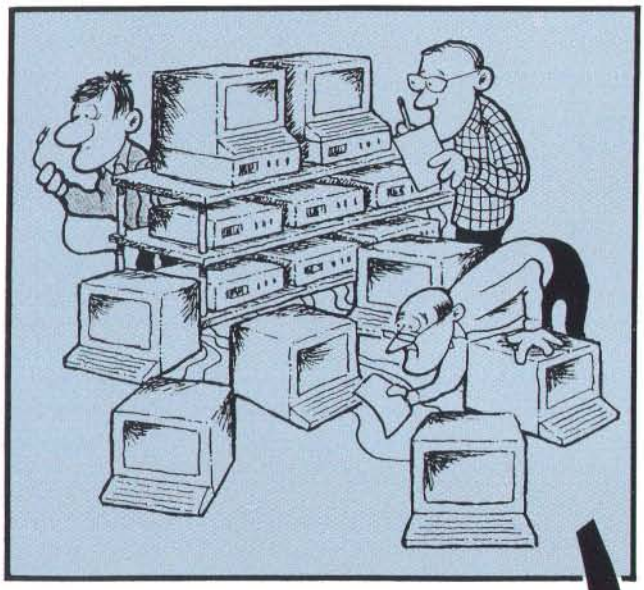

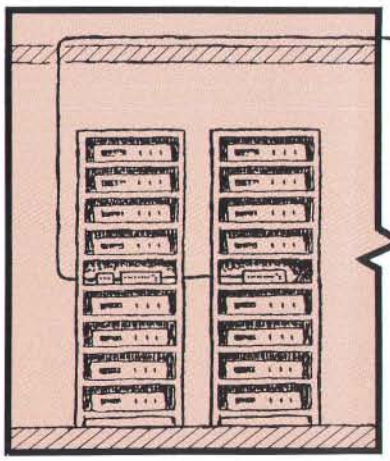

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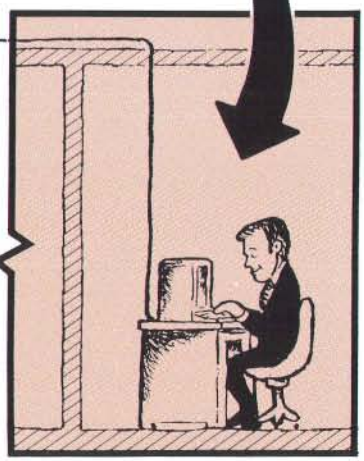

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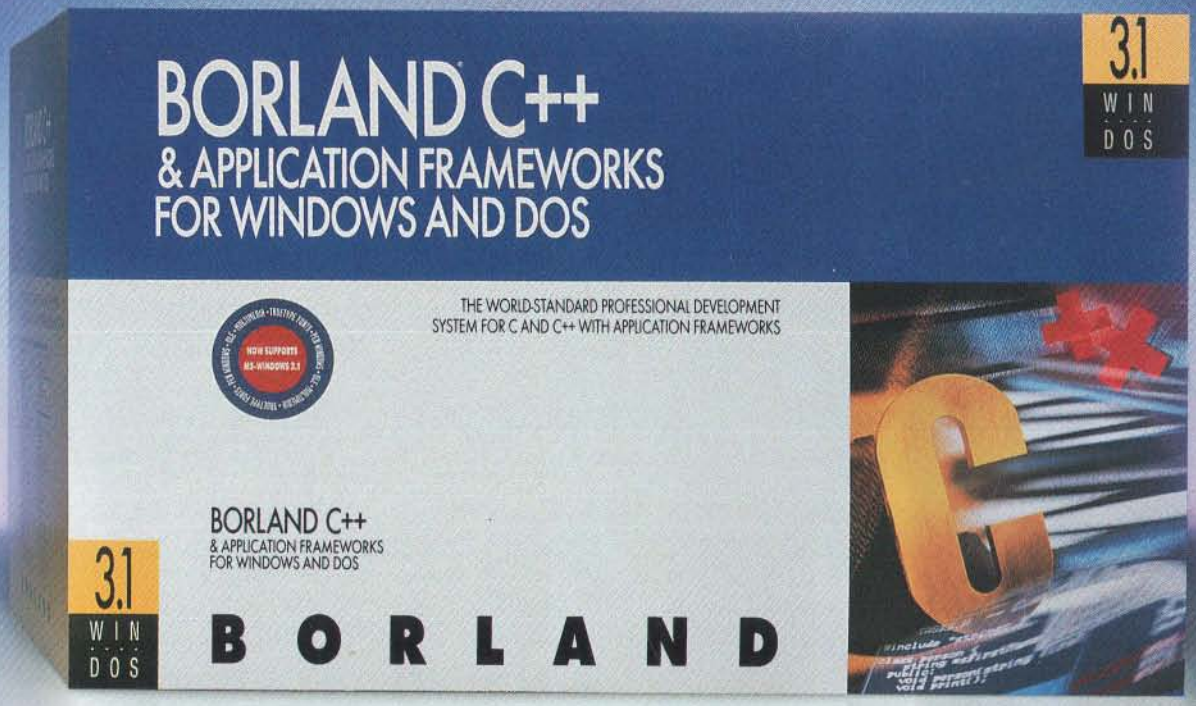

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